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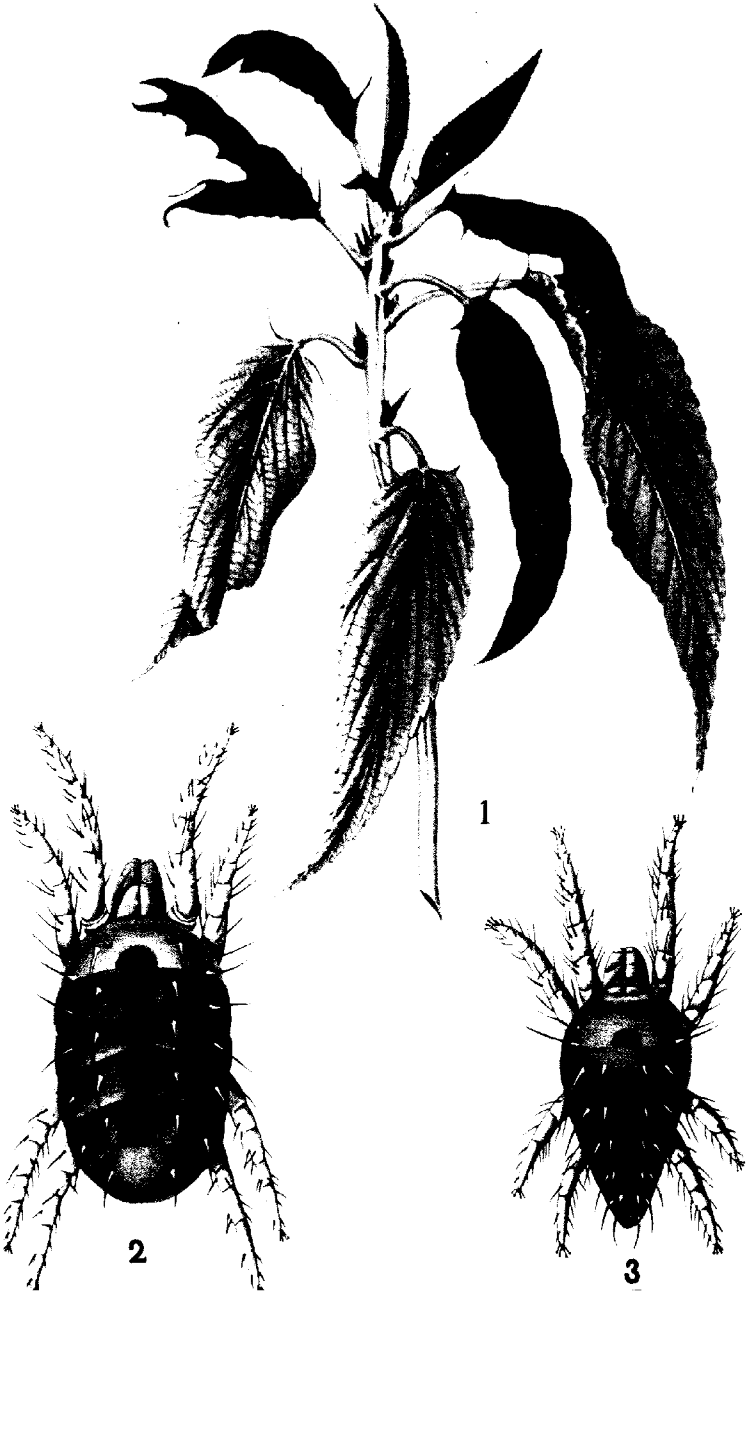
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EXPLA[illegible]ION O[illegible]E X[illegible]II.

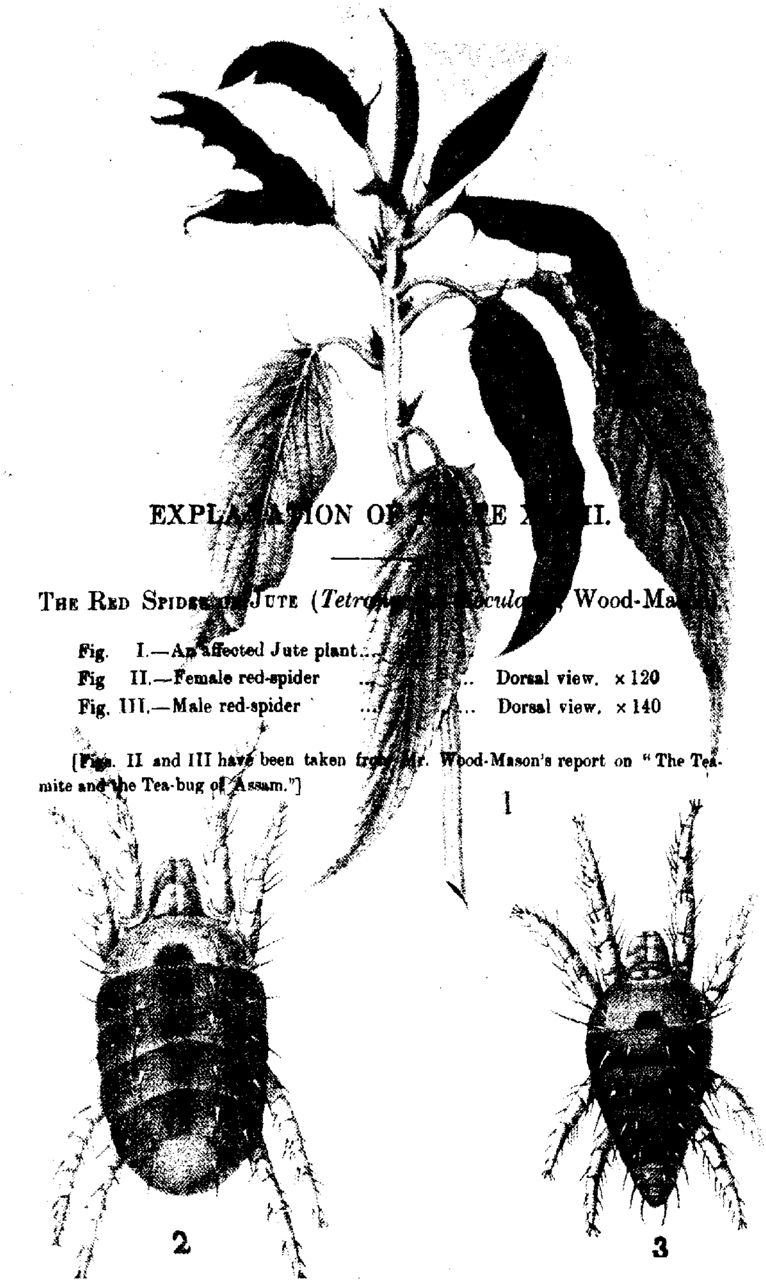
The Red Spid[illegible] Jute (*Tetr[illegible]cul[illegible]*, Wood-Ma[illegible]

Fig. I.—An affected Jute plant...

Fig II.—Female red-spider ... ... Dorsal view. × 120

Fig. III.—Male red-spider ... ... Dorsal view. × 140

[Figs. II and III have been taken fr[illegible] Wood-Mason's report on "The Tea-mite and the Tea-bug of Assam."]



THE RED SPIDER ON JUTE.

(*Tetranychus bioculatus*, Wood-Mason.)

BY

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1st Assistant to the Imperial Entomologist.

THE discoloration of the jute leaves so frequently seen in experimental plots and in the fields is brought about by a small phytophagous mite called the Red Spider or the "Spinning mite." belonging to the sub-family Tetranychinæ, Family Trombidiidæ, Order Acarina. It is deep scarlet in colour and is easily seen briskly moving about the lower surface of leaves. It is very active and seldom remains at one place feeding for long. It invariably remains on the lower surface of leaves under a thin whitish web which it spins over itself, possibly as a protection against the inclemencies of weather. It injures the leaves by repeatedly puncturing them and sucking out the sap through the apertures thus made by the aid of the pharyngeal pump with which it is provided.

Like most other injurious insects it wastes a greater quantity of plant sap than what is actually required for its sustenance. It is probably due to this fact that the infested leaves of the jute plant turn a deep copperish green. By repeated punctures a greater quantity of sap is run to waste than is actually taken into the body of the animal, with the result that the superfluous sap, coming in contact with the air, undergoes a change and imparts a peculiar colour to the affected leaves (Plate XXXII), especially the apical leaves. By examining the punctures under a microscope it is evident that the external openings of the orifices—

which often coalesce owing to a number of spiders having punctured at about the same spot—soon harden on exposure and prevent free circulation of the sap in the leaves, which in consequence curl over and become extremely crisp.

In young plants the nymphs and adults of the spider are mostly present on the tender apical leaves, which become crisp and discolored. The growth of the young plants is thus retarded, and the crop appears stunted; the affected plants begin to send forth side shoots, and the after effect is that the crop, instead of being a valuable one, from the point of view of fibre production becomes useless.

Besides Jute, the Red Spider is also found on Cotton, Castor, Mulberry, Orange, Indigo, *Trumpheta neglecta, Urena lobata, Hibiscus ficulneus, Hibiscus penduriformis* and *Hibiscus abelmoscus*. In the case of castor, when the crop is badly infested the leaves turn pale yellow and become unfit to be served to Eri worms (*Attacus ricini*, Boisd.). The spider confines its attention to the tender apical leaves, and when these become crisp and leathery in consistency, owing to the absence of sap, it leaves them and wanders about in search of fresh plants. It may then be seen running down the stems and webbing up a thin film, at the roots of young plants, to facilitate its passage over clods and other declivities in the ground. Unlike jute, the castor leaves do not turn coppery green, but become pale yellow and drop off prematurely. In some cases, if the crop is specially vigorous in growth, it is able to withstand the attack better than one which suffers from weak growth. It has further been observed that the castor plants reserved for the Eri worms and allowed to stand on the ground during the hot months, when the Red Spider is at its worst, suffer much more than those which are sown mixed with other crops or grown as a fringe round sugar-cane fields, as is generally done in the United Provinces.

The Red Spider has been under observation since 1909, when its attack on jute was noticed for the first time. Ever since, its progress has been watched, and a note made of its alternative food-plants. During May-June 1910 it was bad on castor and last

year when a series of plots were laid down it was found that it was as bad as it was in 1909 when it was first noticed. Last year the spider was found to hibernate in the adult stage on castor leaves, near midribs, veinlets, toxic glands and other depressions on the leaves. As no jute was then available, the observations and trials were mostly confined to castor, which was reserved on the Pusá farm for the Eri worms, but it is hoped that the observations made on castor will hold good for jute also. This year it was found to pass the winter in the adult stage on the lower surface of castor and *Hibiscus abelmoscus* leaves, as well as below clods and fallen leaves below plants. The adults remain inactive till the middle of February, after which, with the first rise in temperature, they copulate and commence laying eggs. Warm, dry weather being especially favourable to its development, the spider breeds prolifically during April, May and June. For this reason, during last April, the leaves of *Hibiscus abelmoscus* were so badly infested that with the webbing on them, the plants appeared white from a distance. The lower surface of the leaves was thickly covered with a thick deposit of silken webbing many layers deep. The plants looked sickly, and were about to die when a heavy shower of rain in the beginning of May cleared off the spiders and made the plants look fresh and healthy again. The past five years' observations have strengthened the conviction that rain is fatal to the development of the spider, either colonies of them are clean swept off or very few of them are left over to continue the progeny. If however warm sunny weather continues to prevail for some time after a rainfall, the spider again develops and the plants suffer consequently. It is for this reason that the discoloration of apical jute leaves, so prominent in the beginning, either entirely disappears or is considerably lessened during a spell of rainy weather, but again becomes prominent as soon as there is a break in the rains.

So far as has been seen the spider remains invariably on the lower surface of Jute, Castor and *Hibiscus abelmoscus* leaves. Only in one instance was it seen to be present in numbers on the

upper surface of castor leaves, but this was an exceptional case, when the crop had suffered much from adverse climatic conditions. Ordinarily, the adults, the day after reaching maturity, begin to couple and lay eggs. Each female lays from 80 to 90 eggs. The female does not lay all the eggs in a cluster, but she continues to lay them scattered all over the lower surface of the leaves. She does not lay all the eggs in one day but continues to do so for over a week. When all the eggs have been laid, she becomes lethargic and dies soon after. The eggs are laid near midribs and veinlets, mostly in shallow depressions on the lower surface of the leaves. In some cases the eggs were seen covered with a few silken strands, but in most cases there was no covering at all over the eggs. The female, when about to lay eggs, raises her abdomen, the head and the thoracic region being brought low to facilitate extrusion of the egg. In this posture she remains for a few seconds, when a pellucid white globule is extruded and dropped on to the leaf below. In this way two or three or more eggs are laid, then the female turns round and exudes fine silken threads which she glues to one side of the depression. She then moves forward and attaches the other end to the other side of the depression. The egg, as laid on the leaf, is a pellucid white object which seems almost too large to be laid by a creature of the size of the female. It is an oblate spheroid, flatter at one end than at the other. It is thinly covered with whitish filaments which are imperceptible to the naked eye. Prior to the emergence of the nymph it turns pale brown. The empty shell remains attached to the lower surface of the leaf unless it is mutilated by the passing of a large number of nymphs and adults over it or is blown off by the wind and the rain. Four to five days after the laying of eggs, the nymph emerges. It is then pale yellow with only three pairs of legs. Immediately on coming out of the shell it begins to feed and to spin a thin webbing within which it may be seen moving about with ease. The object of spinning a web over it seems to be protective, as on very cold days the dew drops are to be seen adhering to the webbing and not thus coming directly

in touch with the nymphs or the adults. A few days after, the webbing is strengthened and the nymph is then out of danger. It then draws its legs together under the sternum and moults, to come out as an adult. The female is ·45 m.m. long and ·27 m.m. broad, nearly semi-circular in shape and deep scarlet in colour. The rostral sheaths, mandibles, maxillary palpi and the legs are shiny pale brown. The two pairs of eyes are represented by shiny spots edged with black. The male is ·32 m.m. long and ·20 m.m. broad. It is lighter in colour than the female. Its body is broad anteriorly and narrowed posteriorly. As in the female, the rostral sheaths, mandibles, maxillary palpi and the legs are light, shiny pale brown. The two pairs of eyes are represented by little shiny spots ringed with black.

The male is easily distinguished from the female by the shape of its abdomen. In the former the abdomen is rounded anteriorly and narrowed posteriorly, whilst in the latter it is rounded anteriorly as well as posteriorly.

The whole life-history occupies 8 to 9 days. It will thus be evident how the spider overruns the crops. It lays a fairly large number of eggs which mature into adults after only eight days. Thus starting with a fertilised female on the 1st March, there will be three millions and a half of spiders ready to reproduce by the end of the month provided in the first brood the number of males and females was equal and that the climatic conditions were favourable to the development of the adults. From the above it will be clear that if any measures are to be adopted to check the ravages of the pest, they should be promptly adopted in the beginning to prevent it from firmly establishing itself on the plants. When once established, it is not only expensive and troublesome but simply a waste of time and energy to cope with a pest that reproduces itself so fast.

The nymph, as soon as it is out of the shell, begins to suck the juice of the castor leaf with the result that the spot where four or five of them congregate to feed soon turns pale yellow, gradually turning into deep yellow. With the increase in the

pale yellow and prematurely falls off. Prior to the falling of the leaf the spiders leave it *en masse* and either establish themselves on other healthy leaves on the same plant or wander about and ultimately establish themselves on other healthy plants.

Five predators have hitherto been observed to prey upon the mite. One is a small brick-brown Ladybird beetle (*Clanis soror*, We.) about the size of a split Khesari seed (*Lathyrus sativus*). Its larvæ and adults may be seen in numbers on the lower surface of leaves infested by the mite. The adults, as well as the grubs of the Ladybird beetle, may be seen actively running about in search of their victims. Another is a small black *Staphylinid* beetle which may be seen in numbers below infested leaves with its abdomen doubled over its back. The third is a small shiny black Coccinellid or a Corylophid beetle about the size of a split mustard seed. The fourth is a species of *Scymnus* and the fifth is *Brumus suturalis*, Fabr. But all these predators, even when they are present in numbers, are unable to appreciably reduce the number of the mites in a plantation. Rain has a decidedly prejudicial effect upon the mite, either whole colonies of it are clean swept off the leaves or only a few are left to breed, and if it continues for some time, especially during the hot months of May and June, there is little likelihood of the mite being bad during the year. The effect of rain on the spider was observed during the beginning of the hot weather in 1910, and the conclusions then arrived at have been substantiated by the following two years' observations. An extract from the monthly observations book will bear out the point.

April 1912. * * * * *

From the beginning to the middle of the month, the Red Spider was rapidly on the increase in the ratoon castor plot on the farm at Pusa. The plot was sown during May 1910 and half of it was cut back during the following June. The spider appeared on the leaves by the middle of February 1912, in isolated places but by the beginning of March it began to breed and disperse. By the middle of April a majority of the leaves were badly infested, so much so that some of the leaves in the middle of the plants had prematurely turned pale with very minute yellow spots on them. They either became very crisp or thin and papery. Their undersides looked as if covered with a thin film of white, made up of the silken webbing and the empty egg-shells adhering to the leaves. On the 17th April there was a light shower of rain and ·05" was received between 7-15 and 8-30 P.M. On the 20th April there was another light

shower accompanied with strong wind and thunder. On the 21st April a heavy shower of rain accompanied with hailstones of the size of a small walnut fell between 7-30—9-30 P.M. On the 23rd April when the leaves were examined they were found to harbour very few spiders. On some previously badly infested leaves there was no trace of the spider excepting the empty egg-shells, a few nymphal exuvia, and a whitish film showing thereby that the spiders had previously infested the leaves ....

This year, too, the same thing was noticed. In the beginning of May the leaves of *Hibiscus abelmoscus* were badly infested with the mite. The leaves were thickly covered with webbing freely interspersed with fine particles of dust, with the result that the plants from a distance looked blighted. Below the web, myriads of mites in every stage of development were present, so much so that within a square centimetre of leaf-space hundreds, nay thousands, of mites were present. The effect of the presence of so many tiny scarlet creatures on the leaves could better be imagined than described, and it was no wonder if the plants had withered prematurely, had it not been for the timely arrival of a shower of rain on the 8th May when ·44″ of rain was registered. This was followed by another shower the following day when 1·18″ was registered. An examination of the leaves on the 10th May showed that there were very few nymphs and adults left over to multiply and reproduce the colonies. From these observations it is clear that if the plants are sprayed with sufficiently cold water in the early stages of infestation, much good is likely to accrue. In nurseries and plants in pots much good is done by blowing the fumes of burning sulphur on to the affected plants with a smoker such as is used by bee-keepers. But this treatment is out of the question in the field, where much good is done by either dusting the plants with flowers of sulphur or spraying with sulphur mixed with Crude Oil Emulsion. The sulphur to be used must be precipitated or sublimed sulphur. It is no good using Roll sulphur, even though it may be ground very fine, as it clogs the nozzles of the spraying machines. To obtain satisfactory results the plants should be sprayed with :—

Crude Oil Emulsion	$\frac{1}{2}$ pint.
Flowers of Sulphur	2 ozs.
Water	4 gallons

Later on, if the mites are still found on the plants a second spraying is to be given, but with double the quantity of sulphur, which should be thoroughly incorporated with the emulsion by hand, water is then to be slowly added and the whole brought up to four gallons. To obtain satisfactory results in the field it is essential to spray the plants with force pumps, as these send forth a sufficiently strong and continuous shower of spray which penetrates the silken webbing within which the mite remains feeding. With the ordinary Bucket pumps without air-chambers and syringes this cannot be done.

During July 1909, a series of experiments were made against the Red Spider and it was found that to spray an acre of very badly infested jute 40 pints of Crude Oil Emulsion and 5 lbs. of flowers of sulphur were required to keep the crop free of the pest. One out of a long series of experiments would illustrate the above figures :—

			Area	Acre.
Plot No. 24	...	...	"	$\frac{1}{30}$
" " 25	...	...	"	$\frac{1}{30}$
" " 26	...	...	"	$\frac{1}{30}$
" " 27	...	...	"	$\frac{1}{30}$
" " 28	...	...	"	$\frac{1}{30}$

Formula :—

Crude Oil Emulsion	...	...	$\frac{1}{2}$ pint.
Flowers of Sulphur	...	...	2 ozs.
Water	...	...	4 gallons

Machine :—

Gould's Standard Spray Pump mounted on cart.

Time :—

Two hours. (For purposes of calculation, half the day has been charged).

Labour & Cost :—

		Rs.	As.	P.
Two men @ Re. 0-3-3 a day, $\frac{1}{2}$ day	..	0	3	3
Two men @ " 0-2-0 a day, $\frac{1}{2}$ day	...	0	2	0
Crude Oil Emulsion, 8 pints, @ 40 pints for Rs. 6-8-0	...	1	4	9
Flowers of Sulphur, 1 lb., @ Rs. 6-4-0 per cwt.	...	0	4	5
TOTAL	...	1	14	5

SOME PROBLEMS OF RICE IMPROVEMENT IN BURMA.

By

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THE commercial aspect of the Burma rice trade has been fully dealt with in the Note* published last year by Mr. Noël Paton, the Director-General of Commercial Intelligence. In that Note methods of transportation, storage and handling are described and criticised, and the question of relation of prices to the present system of milling and marketing investigated, while at the same time the dominant position of Burma in the world's rice trade is emphasised. From the statistics given it appears that although Burma is only fourth among the provinces of India as regards rice acreage, and second in the proportion of rice to her other crops, her exports constitute about 75 % of the total shipment from the Indian Empire, while she contributes 63% of the western world's imports of rice, against 1·3 per cent. from India proper. These facts and figures make it clear that rice improvement must form a large part of the activities of the local Agricultural Department.

The aim of the present paper is to state the problems of rice improvement which, primarily at least, the Agricultural Department is called upon to solve and also, as far as is possible at present, to indicate the means of solving them. To begin with, it is obvious that the nature of the problems to be dealt with must depend on the demands of the milling community, and we

cannot do better than quote from or give a 'précis' of a paper read by Mr. Menzies, Manager of Messrs. Bulloch Brothers & Co., Ld., Rangoon, at the first Agricultural and Co-operative Conference in Burma held at Mandalay in July 1911. Mr. Menzies, as spokesman of the Rangoon Rice Millers, and with the approval of the local Chamber of Commerce, presented to the Conference the views of the milling community on this subject. In the course of his paper he briefly described the milling process as follows :—

"Rough or Cargo rice consists of grain partly husked, say 20 per cent. unhusked to 80 per cent. husked, but of course the percentage of unhusked grain can be reduced if required, at an enhanced cost. Rough rice is shipped largely to Europe and, in smaller quantities, to America and Australia, the greater portion being milled into white rice for human consumption. Protective tariffs and methods of treating the grain peculiar to each country doubtless account for the export of so much rough rice.

"Cleaned or white rice is rice fully husked, and has also the outer skin of the grain milled off. There are five qualities recognized in the Rangoon rice trade, and these vary in whiteness according to the colour of the grain and milling they receive, as also in the proportion of broken to whole grains, say from 25 per cent. broken in the best qualities to 55 per cent. in the lowest qualities.

"Briefly, the process of milling consists of cleaning the paddy of all extraneous matter so far as is possible by means of sifts. The husk is then removed from the grain by a system of hullers, fans and sifts in which process a certain amount of breakage occurs, varying according as the grain is regular or irregular in size, more particularly as regards length. The husked rice is then milled to the required whiteness in cones, in which process a proportion of the grain is broken and what is known as rice bran is taken off. After being put through polishers to remove any particles of a floury nature, the surplus broken rice is sifted out until there remains only the quantity recognized in the

quality of rice being produced. The proportion of broken rice and bran varies with the quality of rice, the percentage of course being highest in the best qualities.

"The broken rice is sifted into several grades, varying in size and colour. Some are shipped to India, Ceylon and the Straits Settlements for human and animal consumption, and some to Europe where they are manufactured into foods, starch, etc.

"Rice bran is the outer skin of the husked grain reduced in the process of milling to a mealy substance. After leaving the cones it is cleaned on special machines, packed in bags, and as a rule shipped to Europe, where it is largely used in the manufacture of cattle foods."

The author of the paper then went on to specify the main essentials of good paddy from a miller's point of view. Briefly these are as follows :—

(1) A bold grain of regular size.—This condition is necessary because in the milling process described above no practical method has yet been devised to separate grains into grades of different size and accordingly the hullers and cones have to be adjusted to a certain mean, with the result that grains which in size are below the mean are left unhulled and appear as paddy in the milled sample, whereas those which are over the mean are broken in the milling process, thus seriously lowering the value of the sample milled. The term "bold" will be explained later: roughly speaking it means a roundish grain as opposed to a long thin one, thinness being correlated with fragility and breakage.

(2) The second point on which stress is laid is uniformity of colour. The presence of red grains, so common in Burma rice, is greatly to be deprecated. On this point Mr. Menzies remarks :—

"Every rice-consuming market in the world is protesting against receiving either rough or cleaned rice which contains more than an extremely small proportion of red grains. No amount of milling will eradicate the red tinge from even the better qualities of cleaned rice, while in rough rice and the lower grades of cleaned rice the red colour is only too obvious."

In addition to these objections to red grain on the part of the consumer there is also the miller's objection that to attempt to remove the red coat entirely in the milling process means the breakage of a large proportion of the white grains. Red grain, in short, is objectionable for the same reason that grain of uneven size is objectionable.

(3) The third point deals also with the same all-important questions of breakage. Awned rices are objected to because the presence of awns tends to increase breakage in the same way.

From the above considerations it is at once apparent that rice-improvement problems are very different from those of wheat or any other cereal. The former is husked and polished only, and, with certain exceptions, the grain is eaten whole. The latter is ground into flour with the result that the question of breakage has no significance, but, on the other hand, the all-important question of 'strength' in the flour at once arises. This is a chemical question which has no parallel, at least not under present conditions, in the case of rice. The two sets of problems may be summarily contrasted by saying that the main problems of wheat improvement are baker's problems and their significance is based on chemical considerations; the problems of rice-improvement are miller's problems and are, for the present at least, more or less of a physical nature. If there is one matter in rice-improvement under Burma conditions which compares in importance with the 'strength' question in wheat, it is essentially the question of 'breakage' of the grain in the milling process.

Let us now consider these questions in some more detail and with special reference to the methods to be employed for their solution at the Experimental Stations. As we have noted above, the main points, *viz.*, grain shape, uniformity of grain, grain colour, and absence of awns, have all special reference to the question of breakage. At the same time the demand for white grain is also clearly a consumer's, as well as a miller's demand. So far as the European consumer is concerned, it apparently does not much matter what the shape of the grain is, at least we have not at

present any information on the point. What we are explicitly told is that he objects to broken samples and red grain.

Taking now in order the several essentials of a good rice we may examine these a little more closely.

I.—GRAIN FORM.

The demand is for a "good bold grain." By boldness is clearly meant an approach to the spheroidal state as opposed to the cylindrical. Clearly what we wish to determine for our selected parent plants is a numerical factor or co-efficient which will adequately express the character involved and which while differing widely in value in different varieties or races will be approximately constant for one and the same variety or race. In this way only can different rices be classified and valued with a high degree of precision. It is clear that the geometrical idea which comes nearest to the rice grain is the ellipsoid of three unequal axes. The cross section of this through the thickest part is an ellipse the area of which is proportional to the product of the two minor axes, *i.e.*, of the breadth and thickness of the grain. Now it is clear that within certain limits and for practical purposes the grain may be considered as becoming rounder and plumper in form if this area increases in size while the long axis diminishes. Hence using the letters l, b, t, to denote length, breadth and thickness of the grain we may conveniently take the expression $\frac{100\,bt}{l}$ as an index, to express the measure of boldness possessed, the multiplication of 100 being to get rid of fractions. That is, we use as our index the quotient obtained by taking one hundred times the product of the breadth and thickness and dividing it by the length. The above index values, however, depend on the unit of measurement used, *i.e.*, whether m.m., fractions of an inch, etc. It would be more in keeping with general usage if the index taken had been $\frac{100\,b \times t}{l^2}$ which would give an abstract number independent of our unit. The two methods, however, lead to the same degree of discrimination and the former has the advantage of having a multiplication less than the latter.

These three measurements length, breadth, and thickness can easily be made to a sufficient degree of accuracy by means of a good screw gauge micrometer and they supply us at once with two very important series of numbers, *viz.*, a series to express relative volumes or size, got by multiplying together these three magnitudes and another series to express "grain-form" or "boldness" as described above. There is, of course, no necessary correlation between the two sets, a very large grain may not be a bold one, and a very bold grain may on the other hand have a very small volume. The amount of discrimination obtainable for "grain-form" depends of course on the accuracy of the instrument used.

Working with a micrometer which read to $\frac{1}{100}$ mm. and taking three widely divergent types of rice grain as an illustration, the following "grain-form" indices were got as means of the determinations.

No.	Class.	Sub-Class.	Grain-form index.
1	Non-glutinous	Slender ... ... Large	64
2	Ditto	Long ... ... Large	95
3	Ditto	Short ... ... Large	110

From this we see that differences of as much as 70 per cent. may be found with reference to the character of "boldness" or plumpness in the grain.

It will be seen that the "grain-form" numbers increase with the boldness and are proportional to it, enabling us at once to classify quantitatively any series of races with respect to that character.

Recently Kikkawa* has used this exact measurement of the grain as basis for a systematic classification of cultivated rices, supplementing actual measurements by volumenometric estimation. The result is a classification admirably adapted for commercial purposes.

II.—Breakage.

There can be no doubt but that breakage in milling depends on more than one factor. In Java† it was noted that there seemed to be a dependence between breakage and the appearance of the husked grain, and that grains of a glassy nature through and through gave less breakage than grains which were white and mealy in whole or parts. From physical considerations, however, it is obvious that the shape of the grain must have most to do with the degree of breakage—hence the desire of millers for 'bold' as opposed to slender grains. Breakage, like grain-form, should be capable of being estimated as a physical constant for any variety, the obvious method being to subject the rice to some degree of pressure and then take the broken grains (measuring either by weight or capacity) as a percentage of the whole. In Java the ordinary country pounding mill was used: in some mills in Burma a rough idea of the degree of breakage of a sample is got by passing a roller over some rice spread on a notched board in order to husk the grain. The husked rice is then put into a bag and the bag beaten against a wall, the number of blows being the same for all samples. The paddy before being rolled is measured in a measuring glass and then the amount of broken grains after beating so measured. To estimate this factor it will probably be found most convenient to improve on the latter method by using a roller of constant weight and furnished with a handle for manipulation, so that the personal factor may as far as possible be eliminated in performing the tests. This would be pushed over

* "On the classification of cultivated rice" Reprinted from the Journal of the College of Agriculture, Imperial University of Tokyo, Volume III, No. 2, Tokyo, September 1912.

† "Onderzoekingen Omtrent Rijst en Tweede Gewassen" by J. Van der Stok, Batavia, 1910.

the rice by the operator, who will, of course, exert no downward pressure. The pressure will thus be fairly constant in each trial, and if, experimental errors are taken into account, the method should prove well enough adapted for comparative tests. It is to be noted of course that the percentage of break got by this method would bear no relation to that got in large milling tests: the result would be comparative only. Incidentally it may be noted that, in the Java tests mentioned above, the break varied from 30 to 80 per cent.

III.—Grain Colour.

The colour of the husked grain may be either white, red or purplish black. A peculiarity of Burma rice, however, is that although any sample of village rice examined between Mergui and Myitkyina will be pretty sure to show a considerable proportion of red grains, black grains are uncommon. The reason is that most black grained rices are glutinous, are generally reaped early, and are used as delicacies and for immediate consumption. Hence contamination of white by black becomes a matter of some difficulty. The grain colour question, then, resolves itself into the elimination of the red. That red acts as a simple dominant to white has been proved by artificial crossing, in Java, where the ratio 3 : 1 was obtained in the F_2, and this appeared also from some tests made at the Hmawbi Station by the author during the last growing season. Hence we may suppose the red to contain a factor which the white lacks. The red colour is in the outer layers of the grain only and does not extend to the endosperm. It is partially removable in hot water and the water in which red rice is boiled is quite red. Red and white grains are never found on one and the same plant: when one grain is red all are red, and similarly with white. A red plant can usually be detected by an experienced cultivator by the darker appearance of the glumes, especially when they are wet with dew; but a too facile dependence on the eye alone is a bad principle on which to perform selection. The real test is to remove the husk, when

the colour of the grain becomes at once apparent. It is quite clear that, if the crop consisted of a simple mixture of pure reds and pure whites, ordinary selection, supposing it to be done carefully, would enable a cultivator at once to purify his crop. The question arises, to what extent cross-pollination plays a part in the matter, for as no trace of such crossing is left in the grain, during the year of the cross such grians will be passed over by a cultivator as white, but will give rise to red plants in the succeeding year. If crossed grains were red in the year of cross, *i.e.*, if xenia as found in maize took place in rice, there might be less difficulty. This phenomenon, however, is not known to take place, and even if it did, would probably be difficult for an ordinary cultivator to detect.

Accordingly, in order to estimate the extent of a cultivator's difficulties, *i.e.*, to determine the approximate extent of undetectable contamination of white by red we are under the necessity of testing for cross-fertilization and red-white heterozygotes in ordinary field crops. The test made by the author was as follows:—From a cultivator's field, known to be growing a mixture of a variety known as red and white Ngasein, 100 heads each of red and white were selected, each head having a grain husked to show the nature of the colour. These heads were sown separately in small raised plots in the nursery, the plots being raised above the water level so that seed could not be washed from one plot to the other till the plants had taken proper root. Watering the seed was done daily, by hand, from the water in the field, until germination took place, and then continued till the young plants were firmly rooted and a couple of inches high. The nursery was then flooded as usual. Each plot was transplanted out in a separate row, giving 100 rows each of white and red. When the plants were ripe every plant in the experiment was examined, by husking the grain by hand, and its colour noted. The results were as follows:—

(1) From the 100 white sowings 2,508 plants resulted, two

(2) From the 100 red sowings 3,839 plants resulted, of which 255 were white and the rest red. In all 22 of these red cultures split up as follows :—

Field No. of culture.	No. of red plants in progeny.	No. of white plants in progeny.
1	50	11
4	42	16
7	41	6
8	31	8
13	27	12
36	5	2
37	60	20
38	6	4
39	51	14
42	19	5
46	22	4
47	51	12
55	35	10
59	30	6
66	63	12
70	32	12
78	43	16
83	39	19
87	39	24
92	34	18
93	43	17
99	47	7
TOTAL ...	813	255

Ratio 3·1 : 1.

This result seems to indicate that, as found in Java, red and white are characters showing Mendelian segregation, the F_2 giving a 3 : 1 ratio with red dominant to white. The actual factor for the cross-fertilization in the previous year is accordingly given by the reds arising from white sowings, *plus* a correction for the reds crossed by whites.

The proportion of reds from white was ·08 per cent. But the original seed showed that the total of red grains in the crop was about two per cent. Hence by the Law of Probability the percentage of red crossed by white would be $\cdot 08 \times \frac{98}{2}$ and combining the two results a simple calculation shows that in this particular case the crossing for the previous year must have been about ·16 per cent. between one and one-tenth per cent. of the whole crop. It is to be noted, however, that this

percentage cannot be looked on as more than the result of a particular case and that it varies according to the composition of the particular sample of seed sown. Meantime it is sufficient to note that the percentage of crossing must be so small that from a cultivator's point of view the elimination of most of the red grain should present no trouble. He cannot, however, unless by chance, completely eliminate it. A residuum of undetectable red will always remain. Hence the work of complete purification is one which must be left to the experiment station.

IV.—Awns.

The remarks made above concerning red grain apply equally in the case of awns. The inheritance of awning has been studied in Java by Van der Stok* who found that in cases of highly developed awning the awned variety is dominant to the unawned, but that intermediate forms also make their appearance. In the particular case, where a cross was made between a very short awned variety and an unawned one, the F_1 generation was entirely without awns. This apparently shows that different factors are at work to produce this character.

In Lower Burma awned varieties are not so common as unawned, so that it is quite easy for a cultivator to overcome the miller's difficulty of awning by choosing a variety known to be free from awns. One of the varieties, however, most desired by millers in Lower Burma, known as Bawyut--Midon, and which is at present under study at Hmawbi consists of a mixture of awned and awnless plants. Cultivators say that it produces most awns when the soil is good, and that then the yield is large. What is probably the case is that some samples of seed contain a larger proportion of heterozygotes (awned) than others, and that it is the existence of these, which, by the well known law of the increased vigour of hybrids, accounts for the higher yield obtained.

The subject of awning, however, requires to be studied more thoroughly in order to be better understood.

The effect of awns on the breakage percentage, is, of course, easily uuderstood. The broken awns left, being of different lengths, tend to make the grains irregular in size, with the result described above.

The points noted above are such as occur mainly in consequence of the demands of the trade. It is obvious, however, that they by no means exhaust the list of the problems to be solved in connexion with the rice crop. On the whole they present the easiest part of the work. Over and above them there is a whole series of questions relating to increase of outturn, by improvement of cultivation, manuring, and specific selection for that purpose. This has been put in hand by the laying down at Hmawbi of manurial and cultivation experiments and by the selection last year of several hundred single-ear cultures. The latter aspect of improvement bristles with difficulties, and the work for some time must be experimental and tentative, even to the number of cultures employed. It has for its object an analysis of cultivators' varieties, with a view to discovering whether new "unit species," from the point of view of yield and the desirable characters, can be obtained from them, and whether, with this object in view, any trust can be put on the eye alone or whether purely random selection will have to be done. To ascertain this, 1,000 plants of each of six varieties were planted out 3 feet apart all ways, so that the complete habit of the plant could be seen. Out of these a few of the apparently very best plants were selected and then seed separately saved and labelled. Then a selection of every tenth plant in the rows, good or bad, was done. All these cultures will be sown in rows during the present season and careful weighments made of their progeny, due care being taken to determine the amount of experimental error. This work should form one of the most interesting and important of the aspects of rice improvement.

Another set of serious difficulties arises from the fact that the limiting factor in successful rice cultivation is the water-

supply. To the tyro in rice cultivation, nothing is more striking than to realize that cultivators readily discriminate between rice fields which to his eye are apparently all on the same level. The cultivator who has worked his holding for years knows better, however, and he generally divides his fields into top, middle and low-lying land, reserving his long-lived paddies for the bottom fields and his short-lived for the higher. Hence the Agricultural Department as a rice-improving agency must be in possession of a series of rice varieties which differ in growth period so as to suit different conditions of water-supply, and its problem is to ensure that in other respects, *e.g.*, grain-forms and colour, uniformity, etc., these varieties shall differ as little as possible. Hence classification of varieties must be of a two-fold nature, they must be divided into groups according to their growing period, and each group must be again sub-divided according to the size, shape, and other characters, of the grain. Only in this way can the uniformity which the trade demands be obtained.

When all such problems have been solved at the Experimental Stations, the all-important question of distribution of seed arises, and the policy which the Agricultural Department in Burma proposes to adopt in this matter may here be shortly stated. The Province possesses in many parts a well organized Co-operative movement. Where such exists it is proposed to utilize it in preference to any other system. A cultivator in a Co-operative Credit Society or Union will be asked to become seedsman for his Society or Union, and to set apart his holding for the purpose. He will receive, annually, varieties for trial from the Experimental Stations, and perform the few simple tests necessary for acclimatisation. The approved varieties he will multiply and sell to his fellow co-operators, recouping himself for his labour by receiving an enhanced price for his improved seed. To ensure co-operators the benefit which ought to be got from using pure seed, the Co-operative Credit Department here are organizing Sale Societies by means of which members are enabled to sell to the mills, direct, and on the most favourable terms. To assist Societies to do this work,

a staff of District Agriculturists is at present being trained on the experimental farms. The ultimate object of the Department is to create a real demand for improved seed, and, with this end in view, to introduce, if possible, the idea of the professional, seedsman as he is known and appreciated in western countries. The Co-operative Credit Organization seems to afford the best starting point for such an idea and it is probably not looking forward too far to imagine a time when seed businesses will spring into existence here, as in more advanced countries. Much, of course, depends on the active co-operation and assistance of the rice trade itself: it is the demand for improved grain, and the willingness to pay for it at enhanced rates, which alone can set in motion the machinery above described.

THE IMPERIAL BACTERIOLOGICAL LABORATORY, MUKTESAR: ITS WORK AND PRODUCTS.

A REVIEW

BY

J. MACKENNA, M.A., I.C.S.,

Offg. Agricultural Adviser to the Government of India.

THE Imperial Bacteriological Laboratory is situated at Muktesar. It is 23 miles, by a bridle path, North-East of Naini Tal and 13 miles South-East of Almora, so that it enjoys all those conditions of magnificent isolation which are considered desirable, if not essential, for concentrated scientific research.

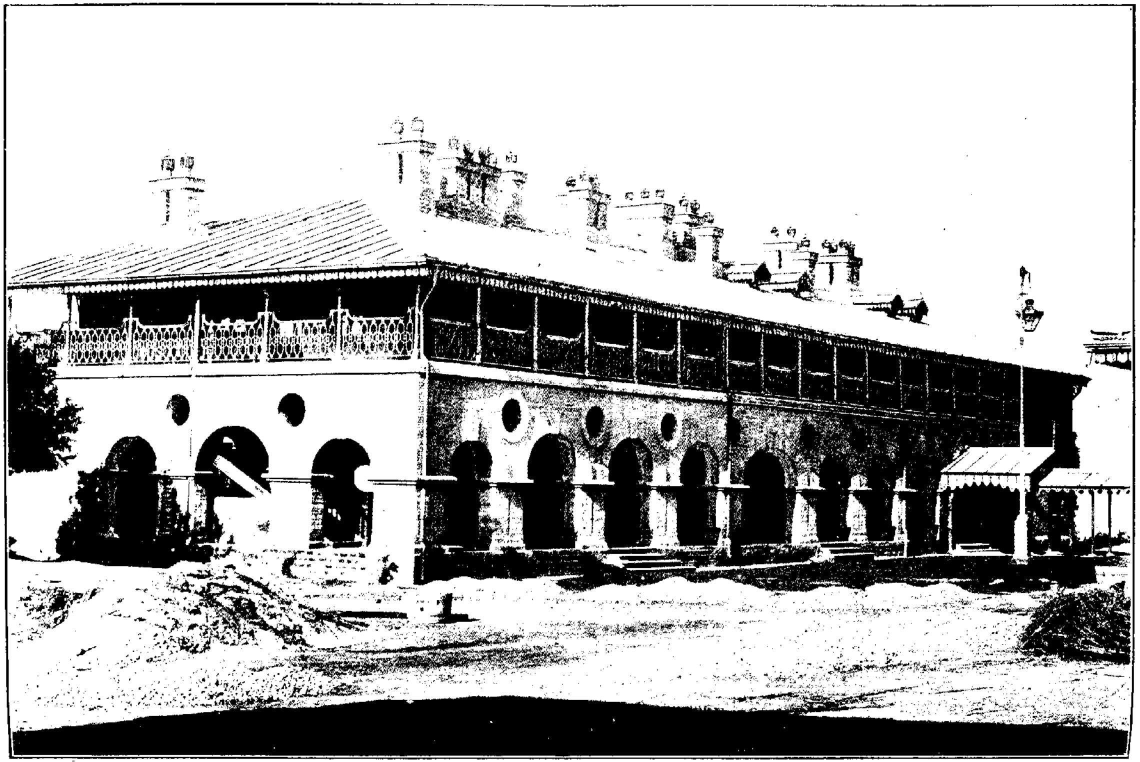
An interesting monograph, giving a description of the Laboratory, its work and products, written by Major J. D. E. Holmes, M.A., D.SC., M.R.C.V.S., &c., the Imperial Bacteriologist, has just been issued by the Superintendent of Government Printing, India, Calcutta. The monograph gives a simple and readable account of the activities and achievements of the Laboratory: is profusely illustrated and should be read by all who take an interest in the progress of Veterinary Bacteriology in India. The object of the present brief review is to convey to readers of the Agricultural Journal of India an idea of what the monograph contains and the great amount of useful work which is being done at Muktesar. Naturally I shall make frequent use of the actual words of the monograph in the course of this description, and I take this opportunity of making a general acknowledgment to Major Holmes for the free use I have made of his own words.

The monograph opens with a short history of the Laboratory. The first step in the direction of the systematic investigation of the diseases of animals in India was taken in 1890, when Dr. Lingard—who will always be remembered as a pioneer of Veterinary Science in India—was appointed Imperial Bacteriologist in connection with the Laboratory at the College of Science in Poona. Investigation, in the earlier years, was principally confined to the disease of surra in horses. It was found, however, that the climatic conditions of Poona were not favourable for bacteriological research and for the preparation of vaccines and sera, and it was resolved to remove the Laboratory to a suitable site in the hills: Muktesar being ultimately selected. Here work, on a small scale, was commenced in 1895 and has continued on an ever-expanding scale ever since.

By this time the importance of the investigation of rinderpest and measures of prophylaxis had come to the front and, in 1896, the distinguished Bacteriologist, Professor Koch, at the request of the Government of India, visited Muktesar, and demonstrated his bile method of inoculation against rinderpest. During the next few years rinderpest and the methods of preparing a potent anti-serum were the principal interests of the Laboratory. This anti-rinderpest serum having been evolved, the scale of operations was extended. The original Laboratory was completely destroyed by fire in 1899: but a new one was built: and increases of building and staff have gone on as the demand for the products of the Laboratory has expanded. A Branch Laboratory was built at Bareilly to admit of a certain amount of research work being carried out during the winter months and this it is now proposed to enlarge considerably, so as to allow of the continuous manufacture of anti-rinderpest and other sera throughout the year. From 1901 to 1904 the preparation of anti-sera for anthrax and hæmorrhagic septicæmia, of black quarter vaccine and of mallein, was added.

Dr. Lingard held the post of Imperial Bacteriologist from August, 1890 to 1908, when he retired. During his absence on leave (November 1898 to January 1900), Major Leonard Rogers

PLATE XXXIII.



Main Building of the Laboratory.

I.M.S., C.I.E., held charge of the post. On the retirement of Dr. Lingard, Captain (now Major) Holmes, who had joined the Laboratory in 1901 as Assistant Bacteriologist, became Imperial Bacteriologist, and has held charge continuously ever since except for the period from February to November 1910 when he was on leave and Major F. S. H. Baldrey, I.C.V.D., acted for him.

The post of Assistant Bacteriologist has been held by the following officers :—

Dr. Stephens—April to June, 1898 ;
Lieutenant (now Major) Walker, C.I.E., 1898-1901 ;
Lieutenant (now Major) Holmes—1901-1907, except for a period of deputation in 1904-05, when the post was held by Mr. Montgomery and Mr. Martin of the Civil Veterinary Department :
Mr. Cross, C.V.D.—1907-1912 :
Mr. Meadows, C.V.D.—1912.

The numerous buildings which go to make the complete equipment of the Imperial Bacteriological Laboratory are built on an estate which comprises some 7,000 acres. Part of this is a reserved forest which supplies timber for the working of the machinery of the Laboratory, and with reference to which Major Holmes exercises the functions of a Conservator of Forests : the remainder, which is under a farm manager, is required for the maintenance of the large herds of cattle which are required for the work of the Laboratory.

The accompanying illustration gives a good idea of the Laboratory Main Building, which, in addition to the actual laboratory rooms, contains accommodation for the clerical staff, chemical store rooms, record rooms, photography rooms, media rooms, incubator rooms—all thoroughly equipped with the necessary apparatus, and provided with water, gas and electric light. In the main building, also, is located the library, which contains some 3,500 volumes.

The further equipment of the Laboratory consists of sheds for the accommodation of the animals used in preparing the various

forms of serum manufactured: operating sheds, a stable for surra experiments, a stable and *post-mortem* house for glanders experiments, and out-laboratories for anthrax, black-quarter and mallein. All the work connected with serum preparation and investigation, in anthrax, black-quarter and mallein, is carried out in their respective out-laboratories. This prevents the risk of infection by sporulating organisms, and of glanders being brought into the main laboratory, and tends to the general safety.

These buildings are on the west of the main building. On the east side are situated the sheds for the cattle used in the preparation of the rinderpest serum, three operating sheds, a *post-mortem* house, incinerator, stables and dog-kennels.

The Out-Kraals—six in number—are situated from 1 to 2 miles from the Laboratory. These provide accommodation for a reserve supply of animals, and for animals which have been under experiment and are being kept under observation for a long period: as also for the segregation of cattle accidentally infected with foot and mouth disease or any other accidental infection.

In addition to the buildings actually used in the work of the Laboratory, there are a Hospital and Dispensary, a bungalow for the accommodation of visitors, a Public Works Department Inspection Bungalow and a well-equipped Institute for the recreation of the Staff—a boon which is much appreciated in this isolated spot.

In Chapter IV of his monograph, Major Holmes describes the difficulties which beset the Veterinary Departments in India in their attempts to tackle diseases amongst cattle. Treatment by approved methods cannot be forced upon cattle-owners, while, although segregation may be insisted on and disobedience of rules visited with punishment, the areas are so vast and difficult to control that no direct attempt at the eradication of any endemic disease is feasible. Again, even if eradication were possible within British India, there is constant risk of reintroduction of

PLATE XXXIV.

Two of the Rinderpest Sheds.

infection along the frontier lines. In view of these numerous difficulties, the operations of the Veterinary Departments are directed towards the suppression of outbreaks of epizootic diseases as they occur.

In these difficult circumstances, the most effective weapons which the Veterinary Department can wield against the constantly recurring epidemics of disease are *sera* and *vaccines*, and these can only be used when the owners consent to have their cattle treated. It is the highest tribute, not only to the soundness of the recommendations made from the Imperial Bacteriological Laboratory at Muktesar, but also to the patience and care of the district officers of the Civil Veterinary Department, that there is an increasing demand for these various sera and injections.

Research and experiment with these sera and vaccines and their manufacture form the principal work of the Imperial Bacteriological Laboratory at Muktesar : the discovery of these sera and vaccines has completely revolutionised the practice of Veterinary Science. But they cannot effect all things, and disappointment is sometimes caused by an exaggerated idea of the possibilities of these agents and an ignorance of their legitimate application. These limitations are thus emphasised by Major Holmes : and as public attention is apt to fix with much keener criticism on failures than on successes, it is as well that the limitations of the efficiency of these sera should be recorded. The following points, says Major Holmes, should therefore be borne in mind :—

(1) No serum can confer anything more than a temporary protection against its specific disease. The periods for which sera protect vary in different diseases, from two weeks to not more than six weeks.

(2) In using serum, the object aimed at is not so much the preservation of each animal treated, as the control of the epidemic and the prevention of the spread of the infection.

(3) No serum or vaccine will protect every animal treated. Many individuals cannot be immunised, either on account of an intense susceptibility or more frequently from the existence of an intercurrent disease.

(4) The duration of the immunity afforded by a serum or vaccine is not in every instance exactly the same. Some animals are protected for a shorter time, others for a period longer than the average.

(5) Serum gives an immediate protection. With vaccines, the immunity is not established for a few days after the injection. Dead vaccines give a protection for a somewhat longer period than serums. Living vaccines produce an active immunity of long duration (several months to one or two years), but their use is attended with the risk of a small percentage of deaths due to vaccination.

Rinderpest or cattle-plague exacts annually an enormous toll of victims in India, and it is to the combating of this fell disease that the main efforts of the Veterinary Departments of India are directed. An anti-rinderpest serum was first prepared by Kolle and Turner in South Africa and used there with success in 1898 : the following year it was manufactured at Muktesar and its use introduced into India.

When it is noted that the object of anti-rinderpest inoculation is to protect healthy cattle at the time of an actual outbreak, by inoculating them and then turning them out together with the infected herd in order that an opportunity of contracting natural infection and a larger immunity may be given, it can easily be imagined that considerable opposition was at first encountered. After a few years, however, the successful results obtained, combined with the patient services of the provincial officers, overcame this opposition, and cultivators now eagerly demand inoculation when an epidemic breaks out. In

consequence, from 1907 to 1910, the maximum output of some 5 lacs of doses was insufficient to meet the demand for serum.

In 1910, improved methods of preparing the serum were discovered—by the application of which in the following year over one million doses were manufactured at the same cost as was previously expended on the manufacture of half that amount.

It may be added that the reputation of the Laboratory, so far at least as the manufacture of anti-rinderpest serum is concerned, has travelled far beyond India, and that large indents for the serum have been received from the Straits Settlements, Egypt and Rhodesia.

But, while the labours of the laboratory staff are, in the main, devoted to the manufacture of anti-rinderpest serum, this does not exhaust their energies. Vaccines and sera are now manufactured for anthrax, hæmorrhagic septicæmia, and *Charbon symptomatique* or black quarter. For the diagnosis or treatment of the diseases of horses, mallein and anti-streptococcic serum are made: and considerable success has been achieved in the treatment of surra by one or other of the following methods :—

(1) Arsenic alone ;
(2) Arsenic and Atoxyl :
(3) Arsenic, Atoxyl and Tartar Emetic ;
(4) Salvarsan alone ; by one or more injections.

The above recapitulation might convey the impression that the Laboratory is merely a great manufactory of veterinary specifics. But this is far from being the case. It is a great centre of veterinary research : the scope of whose efforts will be largely extended when a full scientific staff has been recruited. The finished product is what the public gets, but, to obtain this product, much scientific thought has to be expended : improved methods of manufacture devised : reliability of the specific recommended to be guaranteed : new means of combating disease investigated. An indication of the enormous amount of scientific work done at the Laboratory can be gathered from the record

of the publications which have issued from it, and which are detailed in Chapter III of the monograph.

The monograph is a modest statement of the excellent work which is being done by the Imperial Bacteriological Laboratory on behalf of the great cultivating masses of India, in whose hands are the cattle, the backbone of the agricultural wealth of the country, and we can confidently recommend its perusal to all who have the interests of this class at heart. They will realise that on this side of our work, we are not neglectful of our duties and obligations. That the veterinary profession places some value on the work of the Laboratory is clearly indicated by the fact that the Steel Memorial Medal, for original research in matters pertaining to the veterinary profession, was last year awarded to Major Holmes, the Imperial Bacteriologist.

AMERICAN COTTON IN THE CENTRAL CIRCLE, UNITED PROVINCES.

BY

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VARIOUS opinions have been expressed as to the feasibility of profitably growing a long staple cotton, of the American variety, in the United Provinces, and it seems desirable to place on record the actual results that are being obtained.

American cotton was first introduced into the United Provinces in 1888, and experiments were made with imported varieties at the Cawnpore Farm until 1901. In that year a bulletin was published by the late Mr. Subbiah embodying the results obtained in more recent years. In 1903 some further importations were made, but a remark by the late Mr. Hayman in the Cawnpore Farm report would indicate that the seed issued to cultivators was of the originally acclimatised stock, *viz.*, Upland Georgian. This is, therefore, the probable origin of the cotton now grown under the name "Cawnpore-American." From 1905 an organised effort was made to introduce the cultivation of this acclimatised American cotton on a considerable scale, more particularly around Aligarh but also in several districts of the Central Circle; this was continued after Mr. Hayman left India, and four years ago there was a very considerable area under this crop.

But difficulties arose as to the marketing of the produce and the growing of American cotton collapsed.

It need hardly be pointed out that whenever the introduction of a new crop is attempted in which the additional profit to the grower depends principally on the quality of the produce, special arrangements for marketing are essential : this is particularly so in the case of cotton where the preliminary manufacturing process of ginning intervenes before the principal product comes on the open market. There is always a market in India for cotton with a staple of the "middling American" class, but there are not necessarily buyers of the *un-ginned* cotton willing to pay an adequate price.

In a recent article in this Journal, Leake and Parr have pointed out the requisites of the ideal cotton for the United Provinces. It is of interest to see how far the acclimatised Cawnpore-American cotton satisfies these. As regards yield it may be safely stated that the yield is fully equal to that of the best *desi* when both are grown under favourable conditions. Seed of this variety was obtained from two zemindars, last year, who had continued to grow this cotton for four years *on account of its superior yield.**

In 1912 eight acres of this cotton was grown at the Cawnpore Seed Farm, in close proximity to twenty acres of the Aligarh White Flowered selected *desi* (which is an excellent yielder) on land recently taken over from cultivators; the average yield of each was approximately 9 maunds per acre. At Etawah, on better land, and with a rather better season than was experienced at Cawnpore, American cotton yielded 14 maunds of *kapas* per acre and Aligarh White Flowered *desi* 12 maunds per acre.

Ginning Outturn.—In this respect American cotton of the variety referred to above is at a disadvantage compared with the local Indian cottons, since the former gins (in bulk) 31 per cent. lint to *kapas*, whilst the latter usually gins 33 to 34 per cent. and the selected cotton above referred to 38 to 40 per cent. This not

* [The fact that they were able to obtain a fair price for their product from small village spinners (who often do their own ginning) was probably of equal importance.]

only discounts the additional price due to the superior lint but also means that ordinary middlemen, buying on the basis of *desi kapas,* will not handle small lots of American.

Habit.—The American variety requires a slightly longer growing period than *desi* and, save in very exceptional years, must be sown with irrigation, whilst *desi* cotton can be sown either with irrigation or after the fall of the first rains. This unfortunate limitation restricts the cultivation of Cawnpore-American cotton to early sowings in irrigated tracts.

It is obvious from the above that it is useless to expect cultivators to grow American cotton unless a market can be guaranteed.

At the beginning of 1912, the Elgin Mills Co., Cawnpore, came forward and stated that they were prepared to back their statement that there was a market in the province for long staple cotton by guaranteeing to the growers, through the Agricultural Department, a premium of Re. 1-4 per cotton maund (Re. 1 per standard maund) for American cotton in the form of *kapas.* With this guarantee an effort was made to re-introduce American cotton cultivation in villages around Cawnpore. Seed of the old Cawnpore variety was not available in large quantities and Dharwar-American seed was imported. In all a crop of over 120 bales was produced, ginned under supervision and handed over to the Elgin Mills, who financed the whole transaction and took all risks.

With regard to the Dharwar variety it is sufficient to say here that it has been discarded. On the average it has yielded less than the Cawnpore variety, has a lower ginning percentage, is more susceptible to damage by rain when grown on heavy soil, and produces a lint which, if anything, is slightly inferior to the Cawnpore variety. Seed of the latter variety is now available from our own Seed Farm, and sufficient to sow about 600 acres has just been issued and sown.

Quality of the lint.—The statement has frequently been made that American cotton when grown in India rapidly degenerates until it is no better than the ordinary local short staple cotton:

this is quite incorrect. It is quite probable that some degeneration does take place owing to the changes in composition which invariably occur when a mixed crop is grown in a new environment; this degeneration, if it has taken place, is of an entirely different order of magnitude to the difference between Cawnpore *desi* and Upland American cotton.

Through the courtesy of the Elgin Mills we have been able to arrange for comparative spinning trials on a commercial scale between Cawnpore-American, Dharwar-American and imported "middling" American cottons, and they have kindly permitted the publication in full of the results.

"*Report on the working of Cawnpore-American Cotton, Season* 1913.

Nett weight of cotton	29·43 lbs.
Waste made in Blowroom	4·5%.

Comparative Wrappings of Dharwar-American and Cawnpore-American.

Dharwar-American.		Cawnpore-American.	
Wrappings	Test	Wrappings	Test
25·64	46·33 lbs.	27·77	50 lbs.

Comparative Wrappings of Weft from Mules.

Middling-American.		Cawnpore-American.	
Wrappings	Test	Wrappings	Test
37·03	30 lbs.	37·03	26·16 lbs.

Comparative Wrappings of Twist from Rings.

Middling-American (Imported).		Cawnpore-American.	
Wrappings	Test	Wrappings	Test
23·12	63 lbs.	22·86	58·50 lbs.

General Remarks

"The appearance of the cotton, as we get it, was in almost all ways similar to the American we are getting from Liverpool. Thickness and silkiness of the fibre perhaps 5 per cent. less.

Length of fibre generally equal to our American.

Fineness of fibre, *i.e.*, diameter 5 per cent. to 7 per cent. larger than American.

Strength of fibre only 8 per cent. to 10 per cent. less.

The great fault is the amount of short fibre contained which might be eleminated. This of course means greater loss in the Draw Frames.

Refraction.—This cotton which was run through the same sequence of machines as all our tests lost, as stated, 4·5 per cent. Machines are :

1st Single Crichton Opener combined with small 26" Porcupine Opener.

2nd Buckley Opener combined with Breaker Scutcher.

3rd Finisher Scutcher.

These machines are all new 1907 to 1910 and are all in good order. Through similar machines our American loses 5 per cent.

The cards, drawing, slubbing, inter and roving frames are all new and in good order, all the comparative tests went through the same machines. In the rovings, mules and rings one tooth only extra twist was put in over and above our ordinary American.

The tests as compared with our work have come out very well, the test even for 22·86 warp being very good.

But it is as a weft cotton we should find it useful especially from 26*s*. to 36*s*. counts. Before using it as a fine warp cotton, the short fibres would have to be eliminated. I am now thinking of a 24*s*. warp.

There is no doubt in this cotton if we could get more of it, we should find it of great assistance especially in the weaving of our fine cloths."

(Sd.) W. VERNON,

Mill Manager,

Elgin Mills Co.

The following broker's valuation received from the British Cotton Growing Association, although of less importance than the practical spinning tests above referred to, is of considerable interest as showing the position this cotton would occupy in the English market. It should be added that the sample sent to Liverpool was taken from the last picking, and was not quite as good as the Elgin Mills' sample, which represented the whole crop.

"2 *Bales marked G. G. & Co., Nos.* 302/3.

No. 302, *Cawnpore.*—Equal to about 'low middling' American in grade, rather dull, staple $1\frac{1}{8}''$, silky, strong but irregular. Value in commercial quantities 6·50*d.*

No. 303, *Dharwar.*—Equal to about 'low middling' American, staple about $1\frac{1}{16}''$. Value in commercial quantities 6·25*d.* Low Middling 6·47*d.*"

From the above report it will be seen that the Cawnpore American grown in 1912—at least 10 years, probably 24 years, after the original importation of seed was made—is within measurable distance of ordinary 'middling' American, and consumers are willing to buy it on the basis of the current price of middling American. This cotton has been seen in bulk by many of the Cawnpore spinners, and the opinion has been freely expressed that the various Cawnpore mills, alone, could annually consume from ten to twenty thousand bales of this cotton, without materially altering their existing machinery. It is not perhaps commonly recognised that the Cawnpore mills import considerable quantities of American cotton every year, as well as large quantities of the long staple Indian cottons, such as Broach. Accepting the provincial average for the outturn of irrigated cotton, the abovementioned quantities correspond to an area of twenty thousand to forty thousand acres, so that there is ample scope for several years' work.

The future of American cotton will depend largely on the price obtainable for the lint. Recently *desi* cotton has been dear—in the opinion of many spinners disproportionately so—and any

fall in the price of cotton is likely to affect the lowest quality most. Five years ago, when *desi* cotton was relatively cheap, it was possible to offer cultivators a premium of two rupees per standard maund for American "Kapas" and this may easily recur.

There is some margin for improvement in the crop itself. In the above report reference is made to the presence of short fibres: an examination during the past season of a large number of individual plants has shown that while the crop was on the whole comparatively uniform, there were a number of plants present yielding a distinctly inferior lint. In the same way some plants showed a ginning percentage much below the average. It is hoped that by selection, pure types can be isolated and thus an appreciable improvement effected in the uniformity of the lint and in the ginning percentage: due precautions being taken to prevent cross fertilization. In addition, a preliminary examination is being made of some more recent importations.

It should be stated that the writer fully believes that the best prospects of ultimate success lie in the hybrid cottons now being produced by Mr. Leake. The limitations of the American class from an agricultural point of view are obvious, and the present attempt to extend American cotton growing must be looked upon as a *pis aller*. It has, however, certain advantages of permanent importance. There is a demand for a long staple cotton for Indian consumption, and there seems to be every reason for producing it as long as this can be profitably done, an organisation is being established which will be of great value whenever any better cotton is available for general introduction: and the existing *desi* varieties are being partially replaced by a variety which will neither hybridise with the existing Indian cottons nor with any hybrid cottons, of the Indian type, which it may be desired to introduce later. Further, a market is being developed for long staple cotton in the form of *kapas*.

For the current season, the Elgin Mills have again pro-d to take the whole of the crop: this time with an improved

guarantee of a minimum price with a further additional price on a sliding scale depending on the spot price of 'middling' American.

The writer wishes to acknowledge the generous assistance received from this Company and from Mr. Vernon, and in particular the unfailing courtesy and readiness to assist the Managing Director, Mr. Bevis.

SOME EXPERIMENTS WITH STEAM THRESHING MACHINERY AT CAWNPORE.

BY

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STEAM threshers have been in use in India on a few large estates under European management for a number of years, but little has been done towards their general introduction. The opinion has been commonly expressed that they are unsuitable to the country and, even in official publications, the statement has more than once been made that the methods of the country are not likely to be improved on. These statements appear to have been made without serious consideration.

No one interested in the improvement of the general standard of cultivation in Northern India can fail to be impressed by the necessity of introducing mechanical power at some stage to relieve the pressure on working cattle. Commencing with the *kharif* sowings in June-July there is a constant demand on the bullocks throughout the year, terminating only with the end of the threshing season in the following June. This demand they are unable to fully meet, and the result is a lowering in the general standard of cultivation, and a reduced area under the more valuable crops. The general introduction of mechanical power for ordinary agricultural operations on cultivators' holdings is an impossibility at present, on account of their small area. The raising of water for irrigation and the crushing of sugarcane are suitable operations for the employment of mechanical power, but here also the scope is limited.

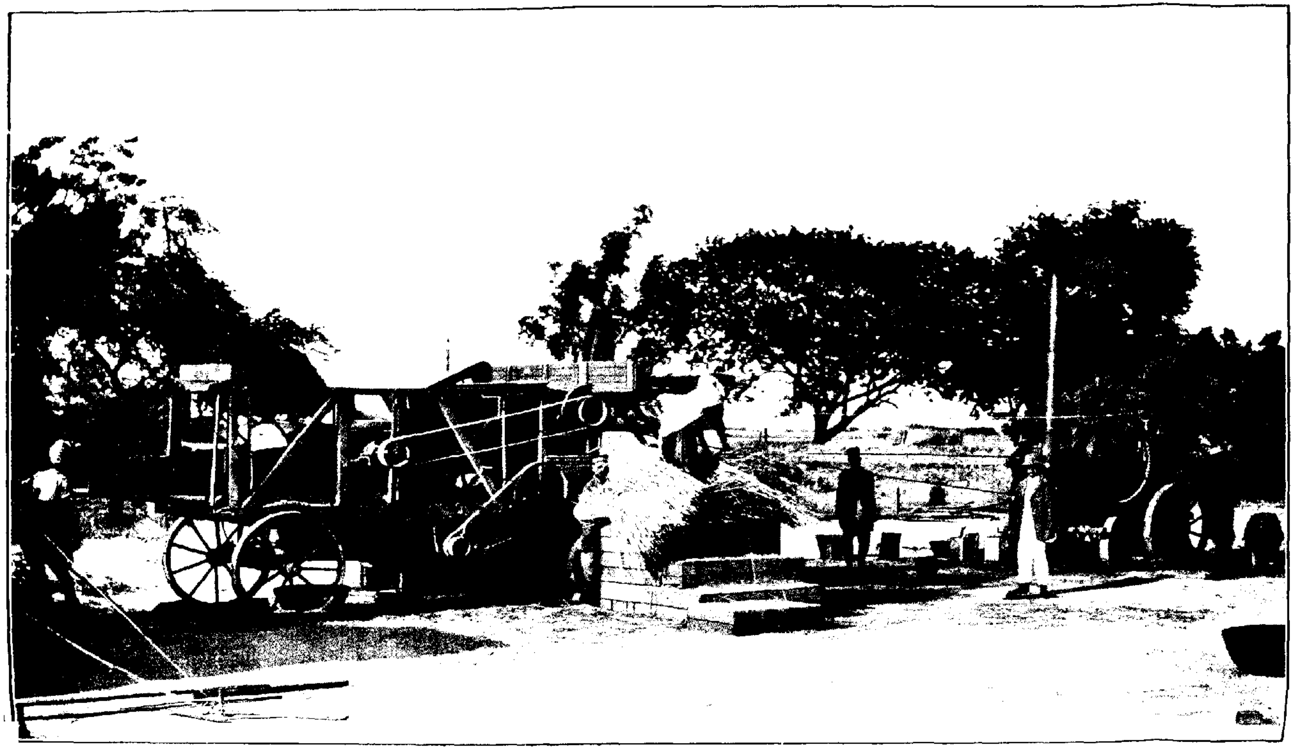
Threshing is probably the one operation of all others which is badly and uneconomically done by present methods, and being one which could readily be performed by contract naturally suggests itself as a suitable stage for the introduction of mechanical power. Under the present system the whole of the available cattle power is occupied in threshing, from the beginning of April until the middle or end of June, and in many cases threshing and winnowing is not properly completed before the rains commence. As a result, the preliminary preparation of the land for *kharif* crops is not satisfactorily done, and hot-weather cultivation for wheat is practically impossible: in irrigated tracts full advantage is not taken of the canal supply to sow early cotton and early fodder crops; and in sugarcane growing tracts, dependent on well irrigation, where the greatest demand for water occurs in April and May, cattle are occupied in threshing which are badly wanted elsewhere.

Again, the process of hand winnowing calls for a large amount of labour at the hottest time of the year, when labour is also scarce and dear owing to the incidence of the marriage season, and, when all is done, the result is not entirely satisfactory since country-threshed wheat and barley is rarely as clean as it should be and the "*bhusa*" is usually full of dust.

It will be admitted that there is ample reason to justify the attempt to introduce mechanical power for the operations of threshing and winnowing.

Experiments were made at the Cawnpore farm and at the Allahabad Exhibition with various types of hand and bullock power threshers. None of these were a success, for two principal reasons. The amount of power lost in transmission in small bullock power machines is abnormally high, and secondly, a single pair of village bullocks (or for the matter of that two pairs) were quite incapable of continuously working the smallest machine tried. All the machines failed in one important respect, *viz.*, their inability to make *bhusa*. One was, therefore, brought back to the oft-stated general principle that for any operation which can be per-

PLATE XXXV.



formed with mechanical power bullock power is an exceedingly expensive source of energy.

Further experiments were made with a small machine driven with a small oil engine, but here again the results were not satisfactory.

It is highly probable that the limited success of steam threshers in India has been very largely due to incomplete adaptation to local requirements. The machine used in the present experiments is a modification of one specially designed by Messrs. Ransome, Sims and Jefferies and exhibited at work at the Allahabad Exhibition in 1910-11. Important alterations have since been effected as a result of the experiments carried out by the makers expert at Allahabad and subsequently at Lyallpur. A detailed description of the machine would be out of place here, but it may be of interest to outline some of its special features. Most machines recommended for use in hot countries, where the straw is harsh and brittle requiring thorough disintegration before being fed to cattle, consist of the ordinary standard type of thresher with an attachment for straw chopping and bruising. Such machines are not an unqualified success, the capital cost and power required being high compared to the output. The machine illustrated on the opposite page attempts to imitate more nearly the native method of making *bhusa* in which the *bhusa* is made in contact with the grain. It contains two special concaves, fitted with a modified form of peg drum in which the pegs, which are of special design, are arranged helically on the cylinder. The bulk of the threshing is done in the first drum and here also the straw is thoroughly bruised and broken up. In the second concave the threshing is completed and the straw converted into fine *bhusa*. As a consequence of the special arrangement of the concaves a long "shoe" is provided running the whole length of the machine. A further feature of the machine is the elevator to the dresser, in which considerable adjustment is afforded, to ensure clean threshing and the minimum of breakage when working with either bearded or bald wheats. A 30″ machine (N. I. L. 30) was used driven by a three nominal horse power, portable,

steam engine capable of developing 12 brake horse power. The following figures were obtained on a whole day's run :—

Actual running time	... 7¾ hours.
Time stopped for oiling and adjustments	... 40 minutes.
Time spent on cleaning up	... 25 "
Total	... 8 hours 20 minutes.
Time engine was under steam ...	... 11·5 hours.*
Grain threshed	... 82 maunds.
Corresponding weight of bhusa ...	... 183 "
Coal consumption	... 7 maunds 16 seers.
Cost of Coal	... Rs. 3-6-0

Best run 26½ maunds in 2 hours = 13¼ mds. per hour.
Second best run 21 mds. in 1¾ hours = 12 mds. per hour.

LABOUR.

One driver	... Re.	1	0	0	per day.
One stoker	... "	0	6	0	"
One oiler	... "	0	8	0	"
Two feeders @ 0-4-0	... "	0	8	0	"
Four coolies @ 0-3-6 ...	... "	0	14	0	"
One pair of bullocks (stacking bhusa)	... "	1	0	0	"
Total	... Rs.	4	4	0	
Lubricating oil, etc.	... "	2	0	0	
Total cost per day	... "	9	10	0	
Cost per maund	... One anna ten pies.				

* Unnecessarily long.

The wheat threshed was Pusa 8, grown on land recently taken over from cultivators and not cultivated before the rains. The threshing was clean and the breakage was negligible, though rather more than in the case of Pusa 106 threshed on previous days. (Pusa 8 was found to be "tender," this year both at the seed farm and at the Experimental Farm, and showed a tendency to break, not only in the steam and hand threshers but also when threshed by bullocks in the ordinary way). The *bhusa* was fine and soft and quite suitable for feeding. This *bhusa* has been continuously fed to the farm bullocks, and the general opinion of cultivators and zemindars who have seen it is that it is quite good enough for feeding, although rather longer than the best country *bhusa*, since it is fine, soft and thoroughly crushed.

In subsequent trials the above figures were slightly improved on, and there is no doubt that the machine is capable of dealing with 13 maunds per hour steadily, and of getting through 100 maunds of grain per day, with the ordinary long straw such as is experienced in the irrigated tracts in the United Provinces. On a short run of half an hour, eight maunds were threshed, *i.e.*, 16 maunds per hour. With the shorter straw met with in the unirrigated tracts and in Bundelkhand, a larger outturn of grain is obtainable, since the feeding of the machine is limited by the speed at which it can handle the straw. It should be stated that during the trials the feeding of the machine was left entirely to the farm gang, who had less than a week's training, and the management of the engine and stoking to the native driver. With skilled supervision better results were obtainable, and it was found that the feeding of the machine improved appreciably as the gang gained experience. It was also found that when a small premium was paid to the feeders on the amount of grain threshed, more keenness was shown, and on several occasions we were able to get through 50 maunds in half a day. This reduced the cost per maund to one and a half annas.

The harvest this year was early, and, as the machine was not received until a fortnight after we had finished cutting at the farms, little time was left for district work. The machine was sent on tour in adjoining villages and some quite good threshing was done. A further demand for the machine arose at the end of May and the beginning of June, after some rain had fallen, and much wheat which was too damp to thresh with bullocks was successfully threshed, including some that had been partially threshed by bullocks and which would otherwise have rotted on the threshing floor. Four annas per maund was charged, except in one case where a fixed charge per day was made for threshing wet wheat. Applications for the use of the machine next year have already been received and there is little doubt that it will be fully occupied next season.

It is obvious that steam threshing must as a rule be done by

investment for capital. The size of the machine is in this case of considerable importance, since in larger machines the initial and running expenses are proportionately lower. On the other hand, transport is more difficult with the larger machine, and a larger supply of raw material is necessary, involving more frequent moves.

As far as the threshing is concerned, it was obvious that unless a 42″ machine could be used, which would permit of the sheaves being fed crossways instead of end-on, little economy would result. A 42″ machine would permit of the use of a small traction engine which would haul the machine as well as thresh, and would materially increase the output in proportion to the working cost. The haulage of such a machine over village roads would be a difficulty however, and, for the present at any rate, there would be difficulty, in villages around Cawnpore, in getting sufficient material concentrated.

The cost of the machine and engine landed at Cawnpore is Rs. 5,000, including the necessary spares; of the machine alone Rs. 2,680. Interest, depreciation and repairs at 20 per cent.* amount to Rs. 1,000 per year. Assuming that the thresher works for 60 days per season, threshing 100 maunds per day, at a gross profit of 2½ annas† per maund, we have receipts of Rs. 937-8-0, so that the thresher would barely pay for itself.

There are two directions in which the above calculation is faulty. Firstly, it is not fair to charge the whole of the interest and depreciation on the engine to the threshing.

During the remaining nine months of the year the engine can be employed in a variety of other work such as cotton ginning and grinding *ata*—two operations for which zemindars are beginning to see the advantage of employing mechanical

* Interest at 6 per cent.
Depreciation on thresher 10 per cent.
Depreciation on engine 6 per cent.
Repairs say 300/—6 per cent.

† *i.e.*, a charge of four annas per maund.

power and which are highly profitable—not to mention pumping and sugar-cane crushing, where an equally wide field exists. Under these circumstances, the interest and other charges on part of our capital are reduced by three quarters, in other words, the machine has now to earn Rs. 662 only before making a net profit, which leaves a reasonable margin.

Again, the charge we have assumed of as. 4, per maund of grain for threshing, is much below that charged in Europe (where *bhusa* making is not demanded), and is much below the cost of threshing by bullock power.

By the ordinary country method five pairs of bullocks at the Cawnpore farm threshed 1,000 lbs. of sheaves in 18 hours, corresponding to about 4 maunds of grain. At present prices for bullock hire (Re. 1 per pair per day) this means Re. 1/4/- per maund *exclusive of winnowing*, which latter operation costs under favourable circumstances about anna one, to annas 2, per maund. In neighbouring villages Re. 1/- per maund is a fair estimate for threshing and winnowing.

Using the Egyptian Norag thresher (which costs about Rs. 40/-) we have been able to reduce the cost of threshing to about one-third, *i.e.*, 7 annas per maund for threshing, *plus* 2 annas per maund for winnowing or a total of 9 annas per maund. Making due allowance for the fact that village rates are lower than those obtainable near a town like Cawnpore, it seems a fair deduction that, once the steam thresher is known, the larger cultivators will be willing to pay 6 annas per maund for threshing and winnowing, especially in view of the indirect benefits which have already been mentioned and which most cultivators realise. At this price threshing is a remunerative undertaking.

At first there will be a number of practical difficulties. Until steam threshing is firmly established there will be increasing difficulty in getting sufficient work during the last month before the rains. The distances from place to place will be disproportionate, owing to the scepticism of the more conservative and there will probably be breakdowns due to an imperfectly

trained staff. Such difficulties accompany most new ventures but should not prove insuperable. There is every reason to believe that steam threshing is now a practical proposition and that it will enable the present vicious circle depending on the excessive demand on agricultural cattle to be broken.

AGRICULTURAL PROGRESS IN TRAVANCORE.

BY

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THE following is a short account of the work that has been done towards the development of agriculture in Travancore.

In 1908 a Department of Agriculture was organized with a Director at its head. On the recommendation of the Director the Demonstration Farm which then existed at Trivandrum was converted into an Experimental Station, the superintendent being designated Agricultural Inspector, and his two assistants Agricultural Sub-Inspectors. A new Experimental Station was opened at Kottarakaray, in Central Travancore, and a cattle-breeding farm at Trivandrum: two Agricultural Inspectors and a Laboratory Assistant were newly entertained, and about 2 years later a cocoanut farm was opened at Alleppey in North Travancore. The Laboratory Assistant and one of the Agricultural Inspectors are undergoing training, in agricultural chemistry and entomology respectively, in the Agricultural Research Institute at Pusa, and the laboratory is for the time being in the charge of a temporary substitute.

The Department of Agriculture in Travancore works almost on the same lines as other Agricultural Departments in India. The work includes field experiments, the analysis of soils and manures, demonstrations on cultivators' lands and on the experimental and demonstration farms, and the distribution of small quantities of seeds and manures free of charge; besides lectures,

exhibitions, and the publication of leaflets and reports. A quarterly Agricultural Journal is also being started.

The most noteworthy result of the work of the Agricultural Department is the general interest it has been able to stimulate among the people in scientific agriculture. Even the ryots of out of the way places have opened their eyes and begun to see the immense possibilities that are open to them for improving their agricultural methods. The ever increasing number of enquiries from the ryots of different parts of the State bears ample testimony to the interest they evince in matters agricultural. This is a healthy sign of agricultural progress in the State.

The attempts of the Department for the introduction of light iron ploughs are being attended with a considerable amount of success. The Department usually stocks a number of these ploughs and disposes of them according to demand. In the year 1910-11, 20 ploughs were sold in this manner, but in the following year the number sold rose to 107, and in the current year a still larger number has been sold.

In the matter of manures the most noticeable features are the recognition by the ryots of the necessity of manuring their crops systematically ; the appreciation of the value of locally available manures, such as oil-cakes, fish, etc. ; and the care and attention bestowed on the preservation and use of the all-important cattle manure.

Many ryots who have hitherto been careless in the matter of manuring their lands are now willingly purchasing manures for substantial amounts. Laurel poonac (oil-cake from the seed of *Calophyllum inophyllum*), which is available in large quantities in South Travancore and which has till recently been entirely going out of the State to enrich the lands in other countries, is now very largely used by the local ryots themselves. More than that, the ryots of South Travancore have also begun to use bone-meal, saltpetre, nitrolim, and similar artificial manures, for their rice crop.

In Central Travancore, which is noted for cocoanut cultivation, the Department has opened a few manure depôts for the sale of

manures for the cocoanut palm. In the year 1910-11 manures were sold from these depôts for nearly Rs. 7,000 and in the following year for about Rs. 12,500.

The ryots of Travancore have had erroneous notions about the uses of lime in the soil, but are now gradually changing them, and, as a consequence, liming is becoming a regular practice in some parts of the State.

Single seedling transplantation of paddy is also steadily gaining ground in the State. This method was first demonstrated in South Travancore in 1910-11. In the following year more than 150 acres, and during the current year nearly 500 acres, were brought under this system in that part of the State, while it has extended on a limited scale to other parts as well.

New varieties of rice and sugarcane, and exotic crops such as groundnut, maize, etc., have been introduced into the State and are becoming popular. Banku paddy, which originally came from the Central Provinces, is found to be a better yielder than many of the local varieties of paddy, and is hence very much appreciated by the ryots. Among exotic crops one that is specially suited for Travancore is groundnut, and its cultivation is steadily extending in the State. The increased importance that is now attached to the improvement and extension of sugarcane cultivation all over India has stirred up the ryots of Travancore also. Many of them are discarding the varieties of canes they have been cultivating from time immemorial and are readily going in for new and improved varieties distributed by the Department, while others are opening up fresh lands for the cultivation of this crop.

The cocoanut palm, on which the prosperity of Travancore may be said chiefly to depend, is having its due share of attention. At the instance of the Agricultural Department certain improvements are being effected in the cultivation of this palm, especially in the methods of planting and manuring.

The above are some of the salient features of the progress made till now in the introduction of agricultural improvements in Travancore. The field for work is a very wide one and only a small portion of it has been touched so far. With the advance

of general education which is fast spreading in the country and with the strengthening of the Agricultural Department in its staff and resources which is bound to take place in course of time, the difficulties that now impede agricultural progress in the State ought to disappear and the labours of the Department ought to be crowned with far greater success than at present.

GREEN MANURING AND HOT WEATHER CULTIVATION IN THE PUNJAB.

By

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As some very misleading statements have recently been given currency regarding wheat growing in the Canal Colonies of the Punjab, it has been thought necessary to point out some of the more patent economic factors obtaining in these colonies, in their bearing on the two very important methods of soil improvement known as "green manuring" and "hot weather cultivation."

As regards green manuring, this practice is already in vogue in certain districts, *e.g.*, Jullunder and Ludhiana where *sann* (Crotalaria juncea) and *guvara* (Cyamopsis psoraloides) and *senji* (Melilotus parviflora) are the green manuring crops most commonly used. Of these crops, *senji*, in Lyallpur, often requires as many as six waterings. The crop is a very useful fodder, and an acre would be worth Rs. 40 in February and March when it is generally cut. Ploughing in, therefore, would be wasteful. *Guvara* and *sann hemp* are both *kharif* crops; sown generally in early July. *Guvara*, although less bulky than *sann*, yet is said to decay much slower, and is therefore not so useful as *sann hemp* for the Colonies, especially as, generally, a *rabi* or winter crop has to follow the green manure crop within two months after ploughing in the latter. Most probably, therefore, *sann hemp* is the green manure crop best adapted for the Punjab Colonies.

Now, in the Chenab Colony, irrigation is only promised for $66\frac{2}{3}$ per cent. of the land, *i.e.*, sufficient for the cultivator to crop $\frac{2}{3}$rd of his area annually. Of this area cropped, $\frac{2}{3}$rd is taken in the winter season. As a matter of fact, cultivators as a rule manage to crop their land 110 to 125 per cent. annually, and some do much more than this. (Cultivators are charged for water according to cropped area, and not according to quantity of water used, but slightly different rates exist for different crops). Consider the case of a cultivator wishing to green-manure two classes of land, *viz.* :—(*a*) poor light sandy soil, and (*b*) a fair medium loam.

The cost of green manuring may be approximately estimated as follows :—

	Rs.	As.	P.
(1) Cost of seed (Rs. 4-8 to Rs. 5-0 a maund, at Lyallpur) ...	4	0	0
(2) Sowing and previous cultivation (2 ploughings and a *sohaga*—or harrowing)	3	0	0
(3) Waterings (applying same)	1	4	0
(4) Water-rate (not charged by Canal authorities since 1910-11) ...	......		
(5) Ploughing in of crop	2	0	0
TOTAL Rs. ...	10	4	0

It is advisable to use an inverting plough to get the crop properly covered—in the above estimate it is supposed the native plough would be used. The total cost, Rs. 10-4 calculated in this way, is similar for the two classes of soil (*a*) and (*b*). A truer estimate of the cost can however be got if we consider the value of a fodder crop like, say, a mixture of *guvara* and *jowar* (Andropogon sorghum) grown on the two classes of land. This mixture is commonly grown by cultivators, and as it contains a leguminous crop it cannot be regarded as very exhausting to the soil. In light poor soil the value of such a crop would be Rs. 15 to Rs. 20, whereas in a loamy soil it would be worth Rs. 30 to Rs. 35 per acre. The expenses of cultivation would be very similar to those for *sann hemp*. The above mixture can often be sold on the land so that the expenses of cutting are saved. There is never enough water to crop the land as often as the

cultivator would wish and he naturally regards the cost of green manuring according to the value of the crop it might have replaced, *i.e.*, Rs. 10 or so for poor land, and Rs. 20 to Rs. 25 for fairly good average land. The better the land the higher, therefore, is the cost of green-manuring it. Again, the green-manured crop is generally ploughed-in in early September, and as it requires about 4 or 5 weeks at least to decay very little time remains for cultivating the land for wheat, which is sown before the 10th of November. This decay seems to take longer in the heavier soils than in the light sandy soils, and this seems to indicate another reason for confining the practice to the latter class of soil. The increase in yield also, as far as can be judged from the past two seasons, is greater in light soils. In one case at Lyallpur, with barley, the crop in an area of 3 acres increased from 11½ mds. in 1909 to 42 mds. in 1910-11, after green-manuring in the rains of 1910 (see Annual Report of the Department of Agriculture, Punjab, 1910-11). The above is a remarkable case, as the land had become nearly useless previous to treatment. As a rule the increase in yield is from 3 to 6 mds. per acre, in the first year, in light soils.

From the above it is fairly obvious that the practice of green-manuring for enhancing the yield of good land is very expensive, and at present only of academic interest for the canal colonies.

Hot Weather Ploughing.

In the Chenab Colony, from a ½ to ⅔rd of the area cropped by a cultivator is generally under wheat or barley. Wheat is generally grown on the heavier land if possible. The area of grain being so large it must necessarily follow that wheat often follows wheat in the rotation. The following are the crops which may precede wheat, *viz.*, cotton, *toria* (Brassica campestris)—to a small extent only—gram, fodder crops, such as maize, *guvara*, *jowar*, and sugarcane. Now in case wheat follows cotton, *toria* or sugarcane, these crops being off the land by the end of January, it is the universal custom to plough the land up as soon [redacted] which is generally the case in January, February

or March. The land is thus exposed during the hot months of April, May and June. When, however, the previous crop is wheat, gram or barley, which are harvested in latter part of April and early May, the conditions are very different. At this period the heat is intense (95° to 110°F. in May), and the air very dry. The wheat land at harvest time is dry and very hard, and it is practically impossible to touch it with ordinary cultural implements. Besides, labour is very dear and the cattle are busy threshing the wheat, in case rain should come and cause damage by discolouring the wheat or causing it to germinate. Rates for daily labour at harvest time run from As. 12 up to Re. 1-4 and 1-8 a day. Should rain come, as occasionally happens in May, the cultivators cannot proceed with the harvesting operations, and they do what they can in breaking up land. In ordinary years, however, it would be necessary to water the land in order to be able to plough it at this time of the year; water could ill be spared for this purpose, as the young sugarcane and the cotton require all that is available. The labour question appears, however, to be the greatest difficulty, and it is in this direction that the Agricultural Department is attempting to improve matters, by the introduction of labour-saving appliances in cutting, winnowing, and threshing. Any saving of time by improvements in this direction could be very profitably utilised by the cultivator in intercultivating his cotton and sugarcane, and also, if possible, in tackling his wheat fields.

BERGSON AND BOTANY.

By

ULULA.

Most of us are to some extent familiar with the work of Prof. Bergson, the most brilliantly persuasive philosopher of our times. It represents in some aspects a reaction against the idea of a machine-made universe. He puts science and the human intellect in their proper place below the salt, and in a much-quoted passage compares our view of phenomena to that of a person who inspects one by one the pictures on a cinematograph-film, unable to see the moving whole projected on the screen. He considers that tools and machines have to some extent made man, mentally, what he is, and sees no reason for considering the mentality of an ant to be on a lower plane than our own; it is merely on a different one; the plane, that is, of instinct or intuition as opposed to mechanical reason. There is then more than one kind of intellect, and if our aim is to realise the living universe we must not confine ourselves to the partial view accorded to mere reason.

Bergson believes that it is possible for us to cast off at times the shackles of logical thought, and recommends that, as a mental exercise, the effort should be made, although he admits that the line of instinct is unlikely to guide us to any practical or even tangible results beyond an enhanced consciousness of the living flow and interplay of things. It is of course unfair to charge him, as has occasionally been done, with suggesting that scientific investigators can or might profitably adopt the standpoint of an

On lines determined thousands of generations ago, our human intellects are now moulded for better or worse, tools efficient for progress along those avenues whereby our race has from time immemorial approached the study of matter. Our consciousness of the living flow of things is personal and incommunicable; though it is not capable of being employed to obtain concrete results, it gives a mental light and atmosphere to our meditations.

These remarks may seem to have little bearing on what follows, but we seem to detect the Bergsonian influence, perhaps too large a reliance on the ant-like view, in the opinions expressed or implied in an article which was published in the April number of this Journal as a review of Mr. W. Lawrence Balls' book "The Cotton Plant in Egypt—*Studies in Physiology and Genetics*." We have not read the book, but may quote the reviewer's description. "Possibly no reader of the book, certainly not the layman, will question its thoroughly 'scientific' character. It is a mass of figures, diagrams and curves in which are presented quantitatively in what is, from the mathematical point of view, the most concise and intelligible form, the variations in the environment of the cotton plant in Egypt and in its physiological functions; the correlation between the two being worked out in a large number of cases after the methods popularised by Galton and Karl Pearson. And, without the technical knowledge to enable him to form an estimate of the skill and judgment with which these methods have been used, the reader is free to admire the ingenuity and industry displayed by the author in their application."

"Who," observes the reviewer, "that has gardened in a hot climate, does not know, by the intuition derived from many little unrecorded observations, the stunting effect of the afternoon sun in dry weather, shown in extreme cases by the flagging of leaves and remedied by judicious pruning or shading; or again the unhealthy appearance of plants that are suffering from water-logging either owing to bad drainage or heavy and prolonged rain: and why—why is it necessary to measure and record, as the author has done, the exact value of the factors concerned in any particular case?"

Mr. Balls' *Studies in Physiology and Genetics* were of course not written for the immediate use of amateur gardeners; even a really good *mali* would probably suck but small advantage from their perusal. They appear to represent the foundation for an intensive study of the cotton-plant and its environmental reactions. The reviewer is of the opinion that this is not a fit subject for an economic botanist to pursue. He considers that in such matters he should be content with the *mali's* empirical and half-intuitive knowledge, "the integration of many little unrecorded observations:" that he should at any rate leave the attempt to do original work to those who have leisure, contenting himself with the practically mechanical application of the results handed out to him in peptonized form by the leisured investigator, and that his work should largely or entirely consist of the selection and isolation of types suited to the various local conditions of the country in which he works. That he should be in point of fact a nursery-gardener employed by a Government instead of by a commercial firm; paid to get results, not to try to discover the "reason why."

Save perhaps "for those few Economic Botanists who are more botanical than economic" (and who are doubtless well able to fight their own battles), no one will deny that such a view of their functions is a very sane and reasonable one under the circumstances. The "pure," and purely quantitative, research work of the Abbé Gregor Mendel has given them enough to occupy them profitably for at least a generation, in isolating and combining plant characters to fit man's commercial requirements. Mendel, the leisured investigator, has opened the door. The obvious thing to do is to walk in and appropriate the swag.

So far so good, but the reviewer does not stop here. He says: "But if we assume that these investigations are not blind alleys, that the author had in view some scientific object for the ultimate attainment of which these—may one say—*sordid* quantitative investigations are essential; the fact remains that the large amount of work here recorded does not appear to be

of any immediate economic importance. Moreover, it may be suggested that even from the scientific point of view, the expenditure of time by an official of an Agricultural Department on such work is a mistake. We know that the rendering to Cæsar of the things which are Cæsar's is not incompatible with the highest of ideals. It is questionable whether the field of so called "pure" science should not be left to those whose circumstances permit them a perfectly free selection of phenomena to investigate."

Now here he opens up, designedly or otherwise, a question of wider interest. The quotation referring to Cæsar is perhaps a trifle unfortunate, since this reputed saying of Christ has given rise to bitter theological controversy as to whether it may not be a gloss due to official influence, but apart from that it is surely meaningless in the present connection until we know what *are* "the things that are Cæsar's." In other words, why does a Government, why for instance, does the Government of India, maintain any officers in its Agricultural Department beyond those engaged in purely executive work or in the comparatively straightforward application of known rules? In those branches of biological investigation in which no Mendel has yet smoothed the path, in Bio-chemistry, Bacteriology, Entomology, Mycology, what, to put it bluntly, does Cæsar expect? And what is he likely to get? This is in no way an idle question, even if we consider merely its bearing on the policy governing departmental publications.

It should be clearly realised that the leisured investigator in Europe has up to now rendered only comparatively meagre contributions to the practical needs of workers in foreign lands, and that even those contributions are, more often than not, quite unnegotiable in the peculiar social, physical, and financial conditions of India. India must, in biological investigation, to a great extent work out her own salvation with the resources available on the spot. That we should attempt to cut adrift altogether from Europe and America to form an isolated scientific microcosm, is of course unthinkable and impossible. On the contrary, the natural tendency already

progressively closer connection in other matters besides the purely descriptive and classificatory.

To say that workers at home in, for instance, Entomology, would do better to direct their attention, as they are beginning to do, to such subjects as insect-physiology rather than to discussions about nomenclatorial priority, and that workers in the biological sciences abroad should have the economic aspect always in view, is a fundamentally different position from that which our reviewer takes up when he says "the large amount of work here recorded does not appear to be of any immediate economic importance. Moreover, it may be suggested that even from the scientific point of view, the expenditure of time by an official of an Agricultural Department on such work is a mistake." This can only mean that in the publications of our own Department, for instance, no work which is not of direct economic importance should appear, and no officer of the Department should take up any piece of work unless he can, practically speaking, guarantee that it will lead to some commercially profitable result.

From the point of view of the businessman this is a perfectly sound and sensible position. It is in fact practically identical with that generally adopted by planting communities who employ paid scientific advisers. In actual practice it hardly produces the results one might expect.

A consideration of the relative development of the different sciences which are studied partly for their bearing on Agriculture will throw light on the reasons why such a policy is unsatisfactory. The "direct economic importance" of cattle and plant-breeding has been recognised for many centuries, and now Mendel has indicated to the breeder a royal road to profit: similarly, the extraordinary development of some branches of industrial chemistry in Europe during the last fifty years, largely due to the encouragement of pure research, has resulted in numberless new processes of commercial value, by-products of the general activity. In these cases the sciences, or branches of science, have passed through their period of economic infancy. Firmly [redacted] accurately-ascertained fact, of "*sordid*

quantitative investigations," they are now expanding in a vigorous and confident growth. From the breeder and the chemist we may ask for immediate practical results, and within certain limits (the limits to which the pure researcher has gone) we may expect to get them.

In Bacteriology (save in a minor degree in connection with human disease), in Entomology, and in Mycology there is as yet no such broad basis. These sciences are themselves too new, and in particular the increasing recognition of the extent of their economic importance is of too recent a growth, to permit them to compete on equal terms with such well-established industries, if we may so term them, as analytical chemistry or nursery-gardening. The cheap and efficient control of bacteria, insects, and fungi will come, but only as a consequence of a very much deeper understanding than that which we now possess of their physiological mechanism and of the factors which influence their activities.

Who is to gain that deeper understanding? The reviewer's answer is "those whose circumstances permit them a perfectly free selection of phenomena to investigate." Let us suppose, then, that the Research Department of the Imperial Institute undertakes the elucidation of the unknown factors determining the degree of prevalence of the parasites of Lepidoptera or the effect of a changing electro-magnetic field on the increase or decrease of the toxicity of certain bacteria or root-fungi, or indeed any bit of pure research which might allow us to get at the inside of things instead of indulging in a futile promenade on the surface. Then any necessity for such research in India itself will naturally disappear, and it will be difficult to justify the retention of any officers save those whose duties are purely executive, mechanical, or educational. If it were decided on general grounds that the services of such officers might be retained, but that they should not engage in or publish any work which was not of direct and immediate economic importance, there would seem to be three courses open to them: (1) To research in secret. (2) To do nothing. (3) To do nothing in particular, but to do it very well.

The third course is the one which would probably commend itself. To collect a little of the economic cream which floats on the surface of a subject, to serve it up at sufficiently frequent intervals, dissolved in eye-wash and suitably flavoured, is a process whose value has often been demonstrated. In cases where the subject is so undeveloped that the cream has not yet had time to rise, one can fall back on eye-wash pure and simple, or perhaps manufacture a "cream-substitute" out of Bergsonian intuitions, with a few unverified suppositions and conclusions to impart body to the mixture. But of what ultimate profit is all this, save as a method of advertising? It can hardly be recommended as the policy of a Department in the matter of research.

It seems to us that only a very imperfect appreciation of the real state of biological knowledge as applied to India could suggest the suppression of all not strictly economic work, which is the suggestion made by the reviewer: that unless our energies are to be devoted mainly to advertisement, "pure" research must be recognised in India, as it has been recognised in Europe, America, and Japan, as a *necessary condition* for real progress, not as a luxury or a mere concession to opinion. Two-dimensional science may have its uses apart from advertisement, but if we are never to go below the surface how much "forrarder" are we likely to get in the long run Although we are accustomed to distinguish between "pure" and "applied" science, there is of course no hard-and-fast line between them. The word "pure" in this connection is used for work designed to give us a knowledge of facts, principles, and relations, which may afterwards be applied to problems of economic interest which cannot satisfactorily be solved by intuition or by the exercise of ordinary common-sense.*

To engage in an original enquiry, which may or may not give immediately applicable results, taking as one's subject some animal or plant of known economic importance, is obviously

* The reviewer seems to have wished to combine this idea with that of moral purity, but there seems no need to attach fresh meaning to a well-understood phrase.

the merest subterfuge. It is simply to research in secret, using some well-known name, such as "Wheat-Rust," "Boll-Worm," "Paddy," as a talisman to guard against interference. We are asked to accept the opinion that the records of these clandestine operations should always be carefully screened from the myopic eye of the public, and that our constant aim should be to "keep the patient amused" even though it may only be by blowing bubbles. Surely it would be far better at once to let him know the worst, that, in those branches of science which are still in their economic infancy, India must take her share in supplying the nourishment necessary for growth, unless she thinks that cream-substitutes will meet the case.

The following quotation from the report of a recent speech by Mr. Balfour indicates very clearly the views of one who is justly renowned as a philosophic thinker.

"Lord Rayleigh had expressed a faint regret that in the history of this institution a larger fraction of the labour had been devoted to matters immediately connected with industry than to the abstract or purely scientific investigations on the successes of which, ultimately and as years went on, the future of industry depended. They must all share that regret. It was one of his foremost articles of social faith that it was to the labours of the man of science, working for purely scientific ends and without any thought of the application of his doctrines to the practical needs of mankind, that mankind would be most indebted as time went on. Holding that faith, he desired that as much advance should be made in pure science in those buildings as money and space allowed. The general public did not realize that it was to the results of pure science that they had owed in the past and would owe more and more in the future all great advances in industrial knowledge and practice. *Still less did they realize that the man of science who was working consciously towards that end was only half a man of science, and was not likely to do his scientific work nearly as well as if he were simply and solely occupied in advancing that branch of knowledge with which he was connected. He hoped these truths would slowly and effectually sink into the*

public mind as time went on. If that happened, many of them would see the time come when those responsible for the finances of the country would not feel it necessary to say "What immediate practical results to the taxpayer are you going to get from the sacrifice which you are asking the taxpayer to make?"

If indeed our existence depends so largely upon advertisement that we really cannot dispense with it, let our aim in advertising be to educate, the public on the lines indicated by Mr. Balfour; to combine, as it were, instruction with amusement.

We have written at what is perhaps an intolerable length. Our excuse is that the Agricultural Department as a whole seems to have reached a stage of development where the superficial nature of our knowledge of many fundamental matters is beginning to intrude itself upon our notice. It seems that in response to a demand for immediate "work-a-day" results, we have been tempted into a wide expansion of activities upon an insufficient basis of accurate knowledge, and that the need for concentration upon comparatively restricted lines is becoming increasingly obvious. Under these circumstances such opinions as those expressed in the review under notice, as to the initiation and publication of pure research, if applied to biological enquiry as a whole, are to be regarded as reactionary rather than progressive. The degree of recognition to be accorded to biological research is not a matter to be lightly dismissed, for upon it depends the whole future complexion and status of the Department. Careful observation, organised enquiry and research, the application of its results to practice, the testing, demonstration and advertisement of improvements, and, when a sufficient body of accurate knowledge has been accumulated, the education of others; these may be said roughly to sum up the activities of the Department, a Department which has to do with the welfare of over three hundred million people. Condemn it to a parasitic existence on the brains of experts at home, and the result will be an emasculated fraud. Give every possible encouragement to research on reasonable lines, and in twenty years we shall be a power in the land, a strong and solid growth rooted in Indian soil.

FURTHER WORK AGAINST SURFACE CATERPILLARS AT MOKAMEH IN 1912.

By

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In a previous number of this Journal* an account was given of the success which had attended the use of the method of handpicking the early broods of caterpillars to prevent the destruction of the crops on the Mokameh *tal* by surface caterpillars (*Agrotis ypsilon*). Reference was also made to a trial of the Andres Maire trap for Noctuid moths, and it was hoped that it would be possible to use these traps on a large scale for combating the pest. The present paper records the results of this experiment.

Before giving a detailed account of the present year's campaign, it will be necessary to give a summary of the conditions prevailing on the Mokameh *tal* for the benefit of those who have not read the previous paper. The Mokameh *tal* is a large shallow basin of very stiff clay soil, which is inundated during the

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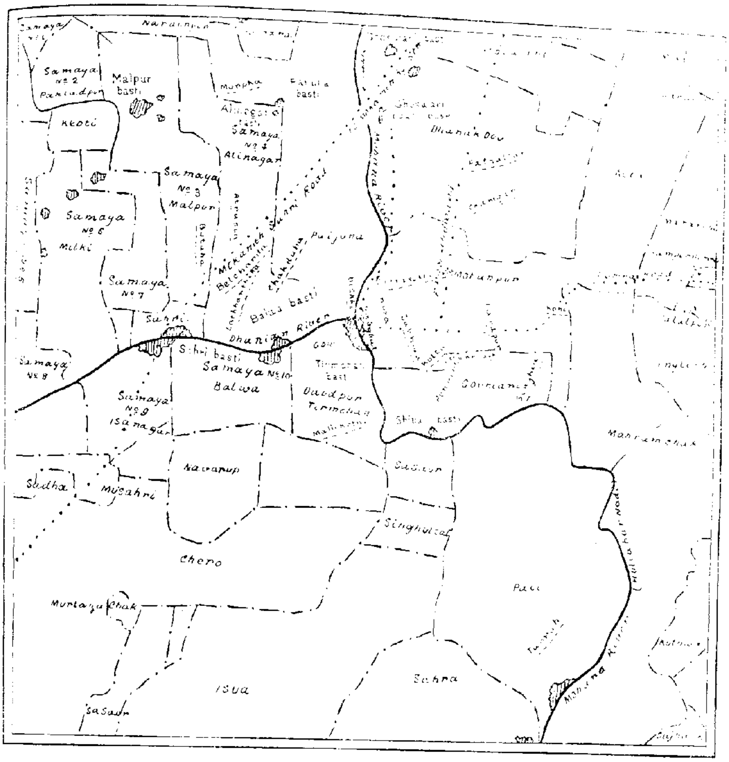
* Vol. VII, Part IV, Oct. 1912. The Caterpillar Pest of the Mokameh *tal*, by E. J. Woodhouse and T. Bainbrigge Fletcher. This summarises the information contained in the two following papers :—

Bengal Quarterly Journal, Vol. IV, No. 4. The Insect Pest of the Mokameh *tal* lands by E. J. Woodhouse and H. L. Dutt.

Bihar Agricultural Journal, Vol. I, No. 1. Surface Caterpillar on *tal* lands by E. J. Woodhouse and H. L. Dutt.

Mokameh Tal; Showing the Village Sites, Mauzas, and Kitas.



Scale 1 inch = 2 Miles

References

Mauza Boundary .... ——·——·——

Road .... • • • • • • • •

River .... ————

rains by flood water from the Gaya hills and by the backing up of the water of the Ganges during high floods in that river. The flood water drains slowly out of the basin through the Mohana river as the Ganges falls in September or October. There is usually an interval of about one month between the drying of the highest and lowest areas; the land is usually ready for cultivation some ten days after the flood has receded. The only crops grown on the *tal* are *rabi* crops such as *Masur* (Lentils), *Khesari* (Lathyrus sativus), and peas which are chiefly confined to the higher areas. As soon as the land is sufficiently dry these crops are sown by means of a *tanr* (a combined plough and drill) without any preliminary cultivation. This implement breaks the land up into large blocks which cover up the seed lying in the moist furrow. The land receives no further treatment until harvest but the blocks slowly break down.

Attention must also be drawn to the habits of the insect (*Agrotis ypsilon*) in as far as they affect the question. The pest is active during the cold weather in the Gangetic plain, and as nothing is known of its whereabouts during the hot weather, it has been assumed that it æstivates in the Himalayas. The moth is a strong flying insect which is not usually attracted by light, but lives for some time as an adult, during which time it feeds and lays eggs. It appears to be especially attracted by newly ploughed or irrigated soil on which it lays its eggs. The caterpillar lies hidden in cracks in the soil by day and feeds at night by cutting off the stems of young plants. The extent of the damage caused by the caterpillar depends on the fact that it does not content itself with making a meal off the first plants cut down by it, but moves about freely and may cut off a large number of plants in one night. In spring the life history of the insect takes about six weeks, but there is evidence to show that this is reduced to a month in autumn.

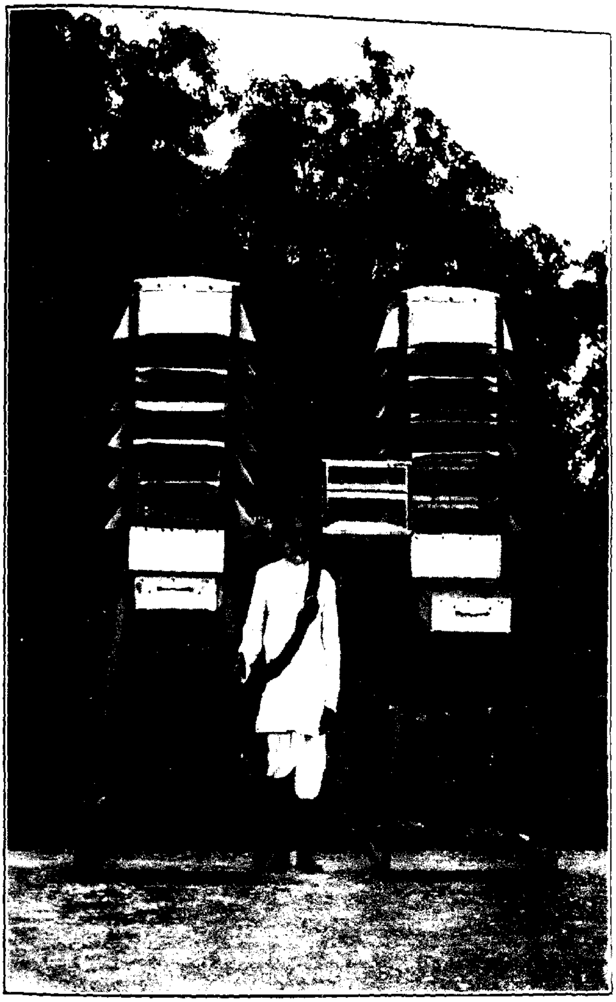
In the *rabi* season of 1909 the Patna Divisional Agricultural Association drew the attention of the Department to the fact that the crops on the lower areas of the *tal* had been destroyed annually by caterpillars during the previous fifteen

years. This information was received too late to enable anything to be done that season, but an inspection of the *tal* showed that the crop had been destroyed over an enormous area in that year.

In 1910 various experiments were tried, and a careful study was made of the conditions prevailing on the *tal*. As a result it was decided that the most promising line of work for the following year was to pick off the caterpillars of the early brood which had been found to appear in the previous year on the higher and earlier sown areas; by this means it was hoped that it would be possible to prevent the production of the destructive brood which had appeared in the lower and later sown areas, six weeks later. This policy was followed, and proved extremely successful, in that it reduced the damaged area from ten thousand to less than three thousand five hundred acres.

At the same time a trial was made of the Andres Maire trap imported from Egypt. There were great possibilities before this trap for the work at Mokameh because it was likely to enable us to attack the pest at an earlier stage than had hitherto been possible. It was hoped that it would be possible to use the traps for the purposes of destroying the moths as they flew on to the *tal* and before they would have had time to lay their eggs. In principle the trap is an application of the well-known method of capturing moths by sugaring, with the addition of a cage which permits the moths to enter but prevents them from escaping (Plate XXXVI). The traps are raised some four feet off the ground in order to increase the distance to which the scent of the attractive liquid is carried. The four sides of the trap each consist of six sloping platforms of wire gauze, the underside of which is horizontal. The moths walk up the projecting platform and enter the trap by a narrow slit between it and the horizontal portion of the platform above. In the morning the moths retire to the darker portions of the trap, and many of them are drowned in a reservoir of water covered with a film of kerosine oil. A pulley is fitted inside the top of the trap, over which passes the rope for raising and lowering the gunny bands on which the attractive liquid is spread. When the trap is in

PLATE XXXVI.



ANDRES-MAIRE TRAPS.

use the bands are charged with the attractive liquid ("Prodenine") and raised at sunset; the traps are again visited the next morning and the bands are lowered and packed away in a box at the base of the trap, after the catch has been removed. In November 1911 nearly three thousand Agrotis moths were caught in one trap.

For the 1912 campaign it was decided to make use of some twenty traps, which were to be stored in the villages of the *tal*, in May, and brought into use as soon as any catches of Agrotis were reported from the observation trap to be worked throughout the rains at Paijuna. The traps were to be organized in batches of about six, each batch being placed under the charge of a trap operator, stationed at Paijuna, Tirmohon, Sahri, and Pali, with head-quarters at Ghoswari. It was not expected that the moths would appear until after the middle of August, and it will be seen that this forecast was correct. As soon as any catches of Agrotis were recorded in the observation trap, the traps were to be taken out of storage and worked on the high lands surrounding the lower areas usually attacked. The traps were to be moved outwards on to the lower lands as the water receded from them.

Great stress was laid on the importance of getting the traps on to the low lands while these were still wet, as our observations in the previous year had led us to believe that the moths lay their eggs on these lands while they are still muddy. At the same time a careful watch was to be kept for broods of caterpillars on the high lands, and any caterpillars found were to be destroyed.

By the time the floods would have finally receded all the traps would be in their final positions on the low lands where the bulk of the damage is usually done, and the work of the staff would consist in supervising the regular working of the traps and in searching continuously for the first appearance of the caterpillars which were to be picked off forthwith.

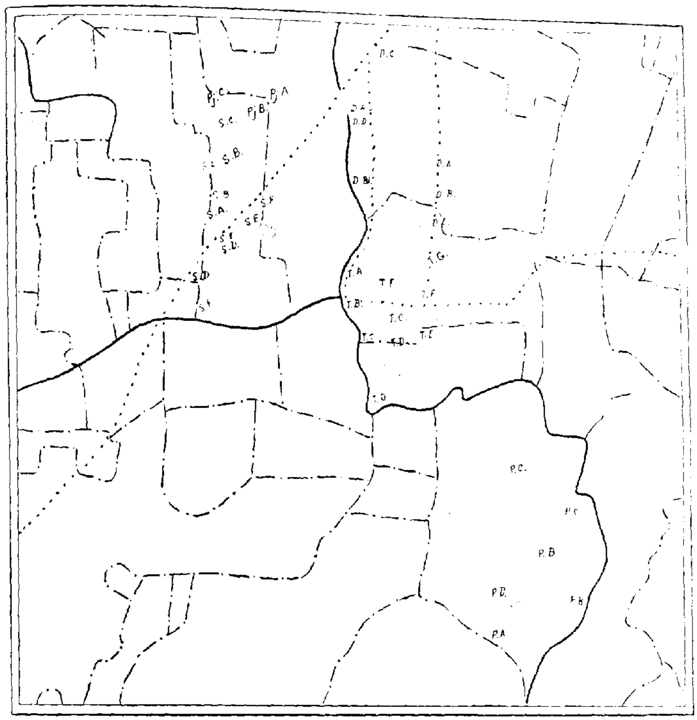
In accordance with this scheme arrangements were made for constructing the necessary traps, which were stored on the

tal by the end of June. An observation trap was worked throughout the year at Paijuna, but in April only thirty-two moths were caught, and from April 28th until August 18th no catches of Agrotis were recorded. On August 27th work was started at Ghoswari, and by September 10th seven traps were working round Ghoswari, Paijuna and Tirmohon, but the commencement of the work at the more distant stations of Sahri and Pali was delayed by the difficulty of procuring accommodation for the trap operators. On September 21st twenty traps were working over the *tal* and the work rapidly settled into shape with the final re-arrangements of the Tirmohon, Sahri, and Pali traps on the low lands on September 22nd, September 24th and October 1st, respectively. That the traps were doing efficient work can be seen from Appendix I. The working of the traps was continued until January 6th, when only two or three moths were being caught nightly in each trap. A daily statement of the catches is given in Appendix I, and the position of the traps is shown in the map opposite. As many as one thousand and three Agrotis moths were caught on one night in one trap.

On September 22nd the first Agrotis caterpillar was found on uncultivated land near Khanwa, but it was not until October 9th that the first attack was reported, from Utra Dakhina (near Sakhoa), and from this time onwards until the end of the month eleven attacks were located and 107,439 caterpillars handpicked and destroyed. The details of these attacks will be found in Appendix II, from which it will be seen that the attacks (with one exception) occurred in close proximity to the traps (see also the map). No damage was done by the pest after October.

In the two previous seasons the agricultural conditions had been abnormal in that the flood water remained on the *tal* for a month later than usual and ploughing could not be commenced until the end of October. The present season, on the other hand, was an abnormally early one. There was no proper flood until the end of August, when a slight flood occurred but began to recede on September 4th. By September 22nd the *tal* was drying very quickly and there was very little flood water left. A

Mokameh Tal; Showing the Position of the Traps and Attacked Areas in 1912.



D_A, D_B &c . . . . First positions of Traps.

T_A, T_B &c . . . . Final positions of Traps.

1 (2) &c . . . . . . Position of attacked area numbered according to Appx. 3.

Pj . . . . Indicates that those Traps were under the paijuna Trap operator

S. . . . . " " " " Sahni " "

D. . . . . " " " " Dhanak Dob " "

T. . . . . " " " " Tirmohan " "

P. . . . . " " " " Pali " "

little cultivation was then in progress in the higher lands, but it was not until September 28th that the sowing of the Mokameh *tal* was commenced in earnest. At this time the *tal* had become so dry that only scattered areas of such high or low lands as had sufficient moisture were being sown. A shower on October 5th enabled a little more land to be sown. It was fortunate, therefore, that heavy rain fell on November 2nd, which increased the germination on the plots already sown and enabled the uncultivated plots to be sown. A second heavy fall of rain occurred on November 24th, 25th, which made it certain that a full crop would be obtained if no damage was done to it by insects or other pests.

The crop over the whole area was practically a full crop, and the actual areas damaged by Agrotis did not exceed 100 acres, though in some places the crop had been damaged by crickets or had germinated badly. The crop over the whole *tal* may be estimated to have yielded 16 mds. per acre, valued at Rs. 2 per md. On this basis* the money value of the outturn of the ten thousand acres of crop normally destroyed by Agrotis works out at 3·2 lakhs of rupees (about £21,000).

With the above information before us we are now in a position to discuss the efficiency of the Andres Maire traps.

That there is no doubt that the normal amount of crop would have been destroyed if no steps had been taken to prevent such an occurrence is proved by the figures showing the number of moths and caterpillars caught. A simple calculation will perhaps make this point still clearer. In 1911 it was found that seven caterpillars per square yard were found on badly attacked areas, so that we may assume that thirty-five thousand caterpillars should be sufficient to destroy one acre of crop and that three hundred and fifty million will be required to destroy ten thousand acres. A reference to Appendix III will show that eight thousand female moths were captured in September, which would each

* Owing to the fact that a bigha is slightly larger than ⅓rd acre, the value of the crop if calculated in bighas works out at 3·6 lakhs (£24,000).

have produced some three hundred eggs, half of which would turn into female moths and give rise to some three hundred and sixty million caterpillars by the end of November. To these must be added some nine millions of caterpillars derived from the moths caught in October and another sixteen millions which would have been produced by the caterpillars picked during that month. It is therefore clear that the insects destroyed, up to the end of October, were amply sufficient to produce the normal amount of damage at the end of November when the attack usually occurs.

In view of these figures the explanations offered by the cultivators of the Mokameh *tal* to account for the decrease in the damage done by Agrotis during the last two years are not very convincing. The decrease is most frequently ascribed to heavy showers of rain in November, which are supposed to destroy the caterpillars, but this hypothesis is disproved by a comparison of the rainfall of 1910 and 1911, during both of which years heavy rain fell in the middle of November. In 1910 about the normal amount of damage resulted, but in 1911 the handpicking of the early broods of caterpillars reduced the damage by some 6,000 acres. The absence of the pest on the Pali *tal* has been said to be due to the increase of *Kharhar* grass, but no such increase has been observed by us. Our own study of the local conditions has led us to consider that the conditions during the present year were if anything rather more favourable to the pest than usual, but it is unnecessary to discuss the question in detail here. Sufficient has been said to show that the only satisfactory explanation of the diminution in the numbers of caterpillars on the *tal* is afforded by the work done by the traps.

The Andres Maire traps do not, however, appear to have proved a success in Egypt, and Dr. L. N. Gough, Entomologist to the Egyptian Government, states that the traps have been rejected in Egypt for use against Prodenia because the percentage of females caught in the traps is low and almost all those caught have been found to have already laid their eggs.

The traps are also said to attract moths from a distance, and the females do not always enter the traps, but lay their eggs near them. The traps are said to work better with Agrotis than Prodenia, as in the case of Agrotis the proportion of gravid females caught is higher.

In Appendix III will be found a statement showing the proportion of females to males caught in the traps during the season's work, from which it will be seen that the percentage of females varied from 56·5% during September to 33·07% in November. There was some difficulty regarding the diagnosis at first and the earlier figures are probably not very accurate, but after November 7th the hairiness of the antennæ (bipectinate) in the male as compared with the absence of hair (filiform) in the female was taken as the critical character.

A series of observations was made on the amount of eggs remaining in the female moths caught in the traps and it was found that the female moths usually contain a considerable number of eggs. That the catches recorded at Mokameh have been satisfactory both in regard to the percentage of females and their egg content is confirmed by the absence of caterpillars over the *tal*.

There is no doubt that a small proportion of moths do escape from the traps. This can only be prevented by taking particular care to see that the openings by which the moths enter the trap do not exceed one-third of an inch, and that the wire screens are not allowed to press against the bars of the frame, so that the moths may not crawl up the inside of the trap to reach the openings. A study of the map opposite page 376 and of Appendix II will show that during the past season only one attack occurred at a greater distance than a quarter of a mile from the traps, and that some were very close to the traps and had obviously resulted from eggs laid by females which had escaped from the traps. In the case of attack 8 and 9 (Appendix II), Sahri trap, E, was visited by Mr. Pal at night on October 16th and a number of moths were found to be escaping from that trap, but this was stopped by decreasing the size of the openings and by other minor adjustments.

That the percentage of moths which escape from the traps is not a high one can be seen from the figures given below :—

Total moths caught in the traps	=152,622
Total caterpillars picked	=107,439

Parent moths required to produce above caterpillars at the rate of 300 eggs per female moth $=\frac{107,439 \times 2}{300}=716.$

$\therefore$ Percentage escapes $=\frac{716 \times 100}{152,622}=0{\cdot}46$ per cent. (or 1 moth in two hundred.)

The objection raised in Egypt to the traps on account of the distance from which they draw moths is not a serious one at Mokameh, where the traps are required to attract moths from as great a distance as possible. The long range of the traps is shown by the fact that in only one case were any caterpillars found at any great distance from the traps, and in this case the attacked area was two miles from the traps. All the other attacks were probably caused by moths which had escaped from the traps. The fact that only one moth in two hundred escaped from the traps on the *tal* during the year shows that the traps must possess a very wide radius of action when it is considered that the traps were situated at a distance of from four hundred to two thousand yards apart (*vide* Appendix IV). Provided the traps collect the moths from all over the *tal*, effectively, there is very little to complain of in having a few small attacked areas near the traps, where they can easily be found and picked. The damage done by the caterpillars on such areas if picked in time is usually slight.

Enough has now been said to show that the Andres Maire traps would appear to be more efficient under the conditions prevailing at Mokameh than in Egypt. It now remains to consider the cost of the campaign.

The statement below gives both the non-recurring expenditure on the initial cost of the traps and also the recurring expenditure incurred in conducting the present campaign. Details of pay and travelling allowance of the permanent staff deputed to

conduct the campaign and of the travelling allowance of the supervising staff at Sabour are also included :—

		Rs. As. P.	
(1) Non-recurring expenditure :—			
Cost of 24 traps—materials and freight	...	721 0 0	
Labour	...	457 8 0	
Freight to Mokameh	...	100 15 0	
Total cost	...		1,279 7 0
(2) Recurring expenditure :—			
Pay of trap operators and coolies for $4\frac{1}{2}$ months	..	380 10 0	
Handpicking caterpillars	...	158 14 0	
Cooly and cart hire	..	172 9 9	
Chemicals for preparing Prodenine ...	...	136 6 0	
Miscellaneous	...	184 12 0	
Total cost	..		1,033 3 9
(3) Pay of Demonstrator in Entomology, Divisional Inspector and permanent menials deputed to Mokameh	...	747 0 0	
Travelling allowance of Govt. Officers (including Sabour staff)	...	770 0 0	
Total cost	...		1,517 0
GRAND TOTAL	...		3,829 10 9

From the above figures it will be seen that Rs. 3,829 has been spent on saving the crop on 10,000 acres, the cost per acre therefore works out at Rs. 0-6-0 (6*d.*) per acre. It may be necessary to slightly increase this working cost in future years by adding to the number of traps on the Mokameh and Pali *tals*. On the other hand, it may be found that the number of insects on the *tal* will diminish in the course of a few years.

In the present paper no attempt has been made to consider the life history of the pest, but it will be sufficient to say that it is not unlikely that it will be found that *Agrotis ypsilon* does æstivate on the *tal*. This and other questions have been dealt with at greater length in a report in the Agricultural Journal of the Bihar Department of Agriculture, Vol. I, No. 2.

SUMMARY.

An account is given of a campaign in which the Andres Maire moth traps were used on a large scale to check the damage caused annually by Agrotis on ten thousand acres of the Mokameh *tal.* It is claimed that the traps have been completely successful in checking the pest. In the year under review less than one hundred acres were damaged by Agrotis, while more than sufficient insects were destroyed to account for the destruction of the crop over the normally attacked area. The traps appear to be more efficient at Mokameh than in Egypt because they attract all the Agrotis moths within a very wide radius; they attract gravid females as well as males; the number of moths which escape is slight (probably in the neighbourhood of one moth in every two hundred caught), but the caterpillars derived from these escaped moths usually appear near the traps and so can easily be found and picked off.

As regards the economic results of the season's work, it is claimed that a crop worth over £20,000 has been secured by the investment of £ 255 in preventative measures.

APPENDIX I.

Statement of catches in the traps. March to December.

March 1912.

DATE.	Agrotis male.	Agrotis female.	Total of the day.	Weather conditions.	Direction of wind.	Number of traps employed.	REMARKS.
1-3-12 ...	1	5	6	Fair.	N. W.	1 trap throughout month at Paijuna.	
2-3-12 ...	0	1	1	"	"	...	
3-3-12 ...	...	...	...	...	...	...	
4-3-12 ...	...	...	...	...	...	...	No detailed records.
5-3-12 ...	...	...	...	...	...	...	
6-3-12 ...	...	...	...	...	...	...	
7-3-12 ...	18	20	38	...	...	...	
8-3-12 ...	...	...	...	...	...	...	
9-3-12 ...	...	...	...	...	...	...	
10-3-12 ...	...	...	...	...	...	...	
11-3-12 ...	...	...	...	...	...	...	
12-3-12 ...	...	...	...	...	...	...	

APPENDIX I. *March—(contd.)*

DATE.		Agrotis male.	Agrotis female.	Total of the day.	Weather conditions.	Direction of wind.	Number of traps employed.	REMARKS.
13-3-12	...	1	3	4	Fair.	N. W.		
14-3-12	...	0	2	2	"	"		
15-3-12	...	3	3	6	"	"		
16-3-12	...	1	2	3	"	"		
17-3-12	...	2	3	5	"	"		
18-3-12	...	1	2	3	Rainy.	"		
19-3-12	...	0	2	2	Cloudy.	"		
20-3-12	...	0	0	0	Fair.	"		
21-3-12	...	1	2	3	"	"		
22-3-12	...	0	2	2	"	"		
23-3-12	...	1	2	3	"	"		
24-3-12	...	0	0	0	"	"		
25-3-12	...	0	0	0	"	"		
26-3-12	...	0	2	2	"	"		
27-3-12	...	1	1	2	"	N. E.		
28-3-12	...	1	2	3	Rainy.	"		
29-3-12	...	0	2	2	Fair.	"		
30-3-12	...	1	1	2	Cloudy.	N.		
31-3-12	...	0	2	2	Fair.	N. E.		

April 1912.

DATE.		Agrotis male.	Agrotis female.	Total of the day.	Weather conditions.	Direction of wind.	Number of traps employed.	REMARKS.
1-4-12	...	1	2	3	Fair.	N. W.	1 trap throughout month at Paijuna.	
2-4-12	...	1	1	2	"	N. E.		
3-4-12	...	0	0	0	"	N. W.		
4-4-12	...	1	1	2	"	"		
5-4-12	...	0	1	1	"	"		
6-4-12	...	1	2	3	"	"		
7-4-12	...	0	0	0	"	"		
8-4-12	...	1	2	3	"	"		
9-4-12	...	0	0	0	"	"		
10-4-12	...	1	2	3	"	"		
11-4-12	...	1	1	2	"	N. E.		
12-4-12	...	0	0	0	"	N. W.		
13-4-12	...	1	2	3	"	"		
14-4-12	...	0	0	0	"	"		
15-4-12	...	Records not received.			...	...		
16-4-12	...	0	0	0	Rainy.	N. E.		
17-4-12	...	0	1	1	Fair.	N. W.		
18-4-12	...	1	2	3	"	N. E.		
19-4-12	...	0	0	0	"	"		
20-4-12	...	1	1	2	"	"		
21-4-12	...	0	1	1	"	"		
22-4-12	...	0	0	0	"	"		
23-4-12	...	0	2	2	"	"		
24-4-12	...	0	2	2	"	"		
25-4-12	...	0	0	0	"	"		
26-4-12	...	0	0	0	"	"		
27-4-12	...	0	0	0	"	"		
28-4-12	...	0	1	1	"	"		
29-4-12	...	Records not received.			...	...		
30-4-12	...	0	0	0	"	"		

During May, June and July there were no catches in the trap.

Appendix I—(*contd.*)

August 1912.

Date.	Agrotis male.	Agrotis female.	Total of the day.	Weather conditions.	Direction of wind.	Number of traps employed.	Remarks.
1-8-12 ...	0	0	0	Fair.	N. E.	1 trap at Paijuna.	
2-8-12 ...	0	0	0	,,	,,	,,	
3-8-12 ...	0	0	0	,,	,,	,,	
4-8-12 ...	0	0	0	,,	,,	,,	
5-8-12 ...	0	0	0	,,	,,	,,	One additional small trap was worked inside a basti throughout the month. No Agrotis was caught in it.
6-8-12 ...	0	0	0	,,	,,	,,	
7-8-12 ...	0	0	0	Rain.	N. W.	,,	
8-8-12 ...	0	0	0	,,	,,	,,	
9-8-12 ...	0	0	0	,,	,,	,,	
10-8-12 ...	0	0	0	Fair.	,,	,,	
11-8-12 ...	0	0	0	,,	,,	,,	
12-8-12 ...	0	0	0	Rain.	,,	,,	
13-8-12 ...	0	0	0	,,	,,	,,	
14-8-12 ...	0	0	0	,,	,,	,,	
15-8-12 ...	0	0	0	,,	,,	,,	
16-8-12 ...	0	0	0	,,	,,	,,	
17-8-12 ...	0	0	0	,,	,,	,,	
18-8-12 ...	0	4	4	,,	,,	,,	
19-8-12 ...	0	0	0	,,	,,	,,	
20-8-12 ...	0	0	0	,,	,,	,,	
21-8-12 ...	0	0	0	,,	,,	,,	
22-8-12 ...	0	0	0	,,	,,	,,	
23-8-12 ...	0	1	1	,,	,,	,,	
24-8-12 ...	0	0	0	Fair.	,,	,,	
25-8-12 ...	0	0	0	Rain.	,,	,,	
26-8-12 ...	0	0	0	,,	,,	,,	
27-8-12 ...	0	1	1	,,	N. E.	,,	
28-8-12 ...	0	0	0	,,	,,	,,	
29-8-12 ...	0	0	0	,,	,,	,,	
30-8-12 ...	1	2	3	,,	,,	,,	
31-8-12 ...	3	2	5	,,	,,	,,	

September 1912.

Date.	Agrotis male.	Agrotis female.	Total of the day.	Weather conditions.	Direction of wind.	Number of traps employed.	Remarks.
1-9-12 ...	0	6	6	Fair.	E.	2 traps.	
2-9-12 ...	1	6	7	Rain.	N. W.	,,	
3-9-12 ...	2	10	12	Fair.	Dull.	,,	
4-9-12 ...	2	8	10	Cloudy.	N. W.	3 ,,	
5-9-12 ...	21	44	65	,,	S.	5 ,,	
6-9-12 ...	67	101	168	Rain.	S. E.	6 ,,	
7-9-12 ...	180	313	493	,,	,,	6 ,,	
8-9-12 ...	255	488	743	,,	W.	6 ,,	
9-9-12 ...	287	499	786	Cloudy.	W.	6 ,,	
10-9-12 ...	385	459	844	Rain.	S. W.	7 ,,	
11-9-12 ...	221	281	502	Fair.	,,	8 ,,	
12-9-12 ...	131	160	291	,,	W.	8 ,,	
13-9-12 ...	73	82	155	,,	W.	8 ,,	
14-9-12 ...	74	77	151	,,	W.	8 ,,	
15-9-12 ...	39	61	100	,,	S. W.	8 ,,	
16-9-12 ...	55	67	122	,,	,,	10 ,,	
17-9-12 ...	37	49	86	,,	,,	,, ,,	
18-9-12 ...	79	77	156	,,	,,	14 ,,	
19-9-12 ...	116	111	227	,,	,,	,, ,,	
20-9-12 ...	70	97	167	,,	,,	,, ,,	
21-9-12 ...	147	179	326	,,	,,	20 ,,	
22-9-12 ...	316	374	690	,,	,,	,, ,,	
23-9-12 ...	301	310	611	,,	S. E.	21 ,,	
24-9-12 ...	240	252	492	,,	,,	,, ,,	
25-9-12 ...	293	341	634	,,	,,	,, ,,	
26-9-12 ...	306	374	680	,,	,,	,, ,,	
27-9-12 ...	531	634	1,156	Cloudy.	N. E.	,, ,,	
28-9-12 ...	502	703	1,205	,,	S. E.	,, ,,	
29-9-12 ...	761	1,279	2,040	,,	S. W.	,, ,,	
30-9-12 ...	981	1,137	2,118	,,	,,	,, ,,	

APPENDIX I—(*contd.*)

October 1912.

DATE.	Agrotis male.	Agrotis female.	Total of the day.	Weather conditions.	Direction of wind.	Number of traps employed.	REMARKS.
1-10-12 ...	488	631	1,119	Fair.	S. E.	21 traps.	
2-10-12 ...	635	891	1,526	Rain.	,,	,,	
3-10-12 ...	617	741	1,358	Cloudy.	,,	,,	
4-10-12 ...	788	1,152	1,940	Foggy	,,	,,	
5-10-12 ...	2,258	2,479	4,737	Fair.	S. W.	,,	
6-10-12 ...	3,175	3,526	6,701	,,	,,	,,	
7-10-12 ...	2,697	3,176	5,873	Cloudy.	,,	,,	
8-10-12 ...	2,500	3,354	5,854	Fair.	,,	,,	
9-10-12 ...	2,339	2,818	5,157	,,	S. E.	,,	
10-10-12 ...	1,835	1,988	3,823	,,	N. W.	22 ,,	
11-10-12 ...	906	971	1,877	,,	W.	,,	
12-10-12 ...	863	926	1,789	,,	,,	,,	
13-10-12 ...	671	812	1,483	,,	,,	,,	
14-10-12 ...	662	709	1,371	,,	,,	,,	
15-10-12 ...	576	705	1,281	,,	S. W.	,,	
16-10-12 ...	556	626	1,182	,,	,,	,,	
17-10-12 ...	500	563	1,063	,,	,,	,,	
18-10-12 ...	472	431	903	,,	,,	,,	
19-10-12 ...	383	371	754	,,	,,	,,	
20-10-12 ...	336	384	720	,,	W.	,,	
21-10-12 ...	375	347	722	,,	N. E.	,,	
22-10-12 ...	485	322	807	,,	N. W.	,,	
23-10-12 ...	428	174	602	,,	S. W.	,,	
24-10-12 ...	297	238	535	,,	W.	,,	
25-10-12 ...	282	191	473	,,	,,	,,	
26-10-12 ...	270	157	427	,,	S. W.	,,	
27-10-12 ...	279	225	504	,,	,,	,,	
28-10-12 ...	278	181	459	,,	W	,,	
29-10-12 ...	288	135	423	,,	N. E.	,,	
30-10-12 ...	315	144	459	,,	,,	,,	
31-10-12 ...	643	258	901	Cloudy.	,,	,,	

November 1912.

DATE.	Agrotis male.	Agrotis female.	Total of the day.	Weather conditions.	Direction of wind.	Number of traps employed.	REMARKS.
1-11-12 ...	...	...	...	Cyclonic.	E.	...	No records taken.
2-11-12 ...	1,184	233	1,417	Cloudy, drizzling.	E.	22 traps.	
3-11-12 ...	1,128	395	1,723	Dull, cloudy.	N. W.	,,	
4-11-12 ...	1,208	322	1,530	Dull,fair.	,,	,,	
5-11-12 ...	1,488	770	2,258	Fair.	,,	,,	
6-11-12 ...	2,047	622	2,669	,,	N. E.	23 ,,	
7-11-12 ...	2,588	848	3,136	,,	N. W.	,,	Antennæ adopted as critical character for diagnosing females.
8-11-12 ...	2,692	995	3,687	,,	,,	,,	
9-11-12 ...	2,509	915	3,424	,,	,,	,,	
10-11-12 ...	2,029	757	2,786	,,	,,	,,	
11-11-12 ...	1,562	770	2,332	Dull.	,,	,,	
12-11-12 ...	1,679	1,097	2,776	Cloudy.	,,	,,	
13-11-12 ...	1,402	1,154	2,556	,,	,,	,,	
14-11-12 ...	1,404	937	2,341	,,	N. E.	,,	
15-11-12 ...	1,454	641	2,095	Fair.	N. W.	,,	
16-11-12 ...	1,461	673	2,134	,,	,,	,,	
17-11-12 ...	1,030	611	1,641	,,	W.	,,	
18-11-12 ...	678	411	1,089	,,	,,	25 ,,	
19-11-12 ...	1,170	638	1,808	,,	,,	,,	
20-11-12 ...	565	359	924	,,	N. W.	,,	
21-11-12 ...	387	239	626	,,	,,	,,	
22-11-12 ...	485	274	759	Cloudy.	,,	,,	

APPENDIX I. *November—(concluded).*

DATE.		Agrotis male.	Agrotis female.	Total of the day.	Weather conditions.	Direction of wind.	Number of traps employed.	REMARKS.
23-11-12	...	...	...	...	Cyclonic	...	..	Traps not worked.
24-11-12	...	1,736	1,048	2,784	Rain.	E.	25 traps.	
25-11-12	...	1,234	613	1,856	Cloudy.	N. W.	,,	
26-11-12	...	1,191	639	1,830	Fair.	W.	,,	
27-11-12	...	1,571	980	2,551	,,	S. W.	,,	
28-11-12	...	1,766	1,250	3,016	,,	W.	,,	
29-11-12	...	1,562	1,052	2,614	,,	,,	,,	
30-11-12	...	1,601	1,146	2,747	,,	,,	,,	
December 1912.								
1-12-12	...	952	634	1,586	Fair.	W.	25 traps.	
2-12-12	...	948	682	1,630	,,	,,	,,	
3-12-12	...	789	480	1,269	,,	,,	,,	
4-12-12	...	976	620	1,596	,,	,,	,,	
5-12-12	...	930	572	1,502	,,	N. W.	,,	
6-12-12	...	798	498	1,296	Cloudy.	N. E.	,,	
7-12-12	...	788	431	1,219	Fair.	N. W.	,,	
8-12-12	...	556	343	899	,,	S. W.	,,	
9-12-12	...	479	302	781	,,	W.	,,	
10-12-12	...	405	234	639	,,	,,	,,	
11-12-12	...	475	283	758	,,	,,	,,	
12-12-12	...	399	248	647	,,	N. W.	,,	
13-12-12	...	341	254	595	,,	,,	,,	
14-12-12	...	334	230	564	,,	W.	,,	
15-12-12	...	336	220	556	,,	,,	,,	
16-12-12	...	243	140	383	,,	,,	,,	
17-12-12	...	240	104	344	,,	,,	,,	
18-12-12	...	188	125	313	Cloudy.	,,	,,	
19-12-12	...	171	93	264	Fair.	,,	,,	
20-12-12	...	146	89	235	,,	,,	,,	
21-12-12	...	123	65	188	,,	,,	,,	
22-12-12	...	131	73	204	,,	,,	,,	
23-12-12	...	133	82	215	,,	,,	,,	
24-12-12	...	100	41	141	,,	,,	,,	
25-12-12	...	85	66	151	,,	,,	,,	
26-12-12	...	109	61	170	,,	S. E.	,,	
27-12-12	...	105	54	159	,,	,,	,,	
28-12-12	...	88	46	134	,,	N. W.	,,	
29-12-12	...	66	57	123	,,	W.	,,	
30-12-12	...	68	53	121	,,	N. E.	,,	
31-12-12	...	74	55	129	,,	,,	,,	

Summary of catches in all traps.

Name of month.	Total number of Agrotis moths caught during the month.	Average number of moths caught per night per trap.	REMARKS.
September	14,983	*	Average cannot be accurately calculated as the traps were being set up one by one as water receded.
October	56,823	113·9	
November	61,409	89·8	
December	18,811	24·2	
January (6 days)	392	2·6	

* From the records for the last 11 days of September (from 20th) the average per night per trap is 48·5.

APPENDIX II.

Statement of caterpillar attacks.

Name of tal.	Owner of field.	Kita.	Distance from nearest trap.	Size of area attacked.	Number of caterpillars picked and stages of caterpillars.	Dates of picking.	Dates of sowing of attacked field.	Net damage from Agrotis.
1. **Mokameh (Tirmohon side).**	**Feringhi Coomar** ...	**Utra Dakhina** ...	**60 yds. from D. E.**	2 bighas	610—2nd & 3rd stages ...	Oct. 21	30-9-12	1 anna.
2. Do. ...	Feringhi Singh ..	Sakhwa-Kolba ...	60 yds. from T. D.	9 ,,	13,545—2, 3, & 4th stages	Oct. 14, 16, 17, 22, 23 & 24	28-9-12	8 annas.
3. Do. ...	(Resident of Auta) ...	Punrerh ..	300 yds. from T. D.	18 ,,	10,349 ,, ...	Oct. 19, 20, & 21	1-10-12	,,
4. Do. ...	Nursing Singh ...	Do. ...	350 yds. from T. D.	4 ,,	8,460 ,, ...	Oct. 25 & 26	5-10-12	,,
5. Do. ...	Punhit Mahto ...	Do. ..	400 yds. from T. D.	8 ,,	* ,, ...	*	6-10-12	14 ,,
6. Do. ...	Sheo Sahai Singh ...	Chauradih ..	150 yds. from T. E.	7 ,,	7,370 ,, ...	Oct. 26 & 27	8-10-12	8 ,,
7. Do. ...	Babu Lal Singh ...	Darapur ..	100 to 500 yds. from T. F.	2 ,,	8,747—3rd & 4th stages...	Oct. 31	8-10-12	4 ,,
8. Sahri side ...	Harku Lal ...	Belchanda ...	50 yds. from S. E.	2 ,,	671—2, 3, 4th stages ...	Oct. 20, 21 & 22	1-10-12	8 ,,
9. Do. ..	Kashi Mahto ..	Lachhantika ...	200 yds. from S. E.	10 ,,	8,188 ,, ..	Oct. 23, 24, 25, 30 & 31	1-10-12	6 ,,
10. Burhee (Pali side).	Raghunandan and Gajo Singh.	Taurah ...	10 to 300 yds. from P. D.	17 ,,	44,333 ,, ...	Oct. 19, 21, 23, 29, 30 & 31	28, 29, 30-9-12	8 ,,
11. Do. ...	Bhanu Mahto ..	Simana ...	2 miles from nearest trap in Pali.	3 ,,	5,166—3 and 4th stages	Oct. 22	8-10-12	4 ,,

* No picking was done. *N.B.*—1 bigha = ⅔ acre approx.

APPENDIX III.

Statement showing proportion of male and female moths caught in the traps.

Number of Trap.	December.			November.			October.			September.			REMARKS.
	Total No. of males caught.	Total No. of females caught.	Proportion of males to females caught.	Total No. of males caught.	Total No. of females caught.	Proportion of males to females caught.	Total No. of males caught.	Total No. of females caught.	Proportion of males to females caught.	Total No. of males caught.	Total No. of females caught.	Proportion of males to females caught.	
D. A.	431	757	1:1·76	610	777	1:1·27	1,195	563	2·12:1	261	152	1·71:1	
D. B.	557	871	1:1·56	1,897	1,844	1·03:1	2,765	2,094	1·32:1	427	321	1·33:1	
D. C.	...	...	...	108	123	1:1·14	176	90	1·95:1	5	12	1:2·4	
D. D.	...	...	...	61	86	1:1·41	781	318	2·45:1	81	70	1·15:1	
D. E.	...	...	...	...	...	...	748	407	1·83:1	473	330	1·43:1	
Pj. A.	506	827	1:1·63	766	967	1:1·26	519	277	1·87:1	81	77	1·05:1	
Pj. B.	26	61	1:2·35	428	333	1·28:1	605	310	1·95:1	64	61	1·05:1	
Pj. C.	169	220	1:1·30	598	491	1·21:1	819	375	2·18:1	83	82	1:1	
S. A.	235	289	1:1.23	1,183	969	1·22:1	1,095	786	1·38:1	189	145	1·30:1	
S. B.	300	340	1:1·13	1,117	1,573	1:1·41	1,510	794	1·90:1	189	117	1·61:1	
S. C.	189	272	1:1·42	821	952	1:1·16	909	640	1·42:1	200	193	1·04:1	
S. D.	191	221	1:1·15	1,391	1,208	1·15:1	1,126	938	1·20:1	214	177	1·19:1	
S. E.	278	300	1:1·08	1,278	1,152	1·11:1	1,172	784	1·49:1	206	114	1·80:1	
S. F.	246	351	1:1·42	1,247	1,070	1·17:1	1,321	765	1·72:1	223	158	1·41:1	
T. A.	532	611	1:1·15	986	1,149	1:1·16	1,988	958	2·07:1	495	330	1·50:1	
T. B.	577	639	1:1·10	1,502	1,453	1·03:1	1,477	784	1·88:1	141	133	1·06:1	
T. C.	809	963	1:1·19	1,822	1,767	1·03:1	2,442	1,160	2·10:1	590	419	1·40:1	
T. D.	382	441	1:1·15	1,903	2,155	1:1·13	1,565	1,023	1·54:1	518	442	1·15:1	
T. E.	515	460	1:12·1	2,203	2,212	1:1	2,557	1,149	2·22:1	1,073	714	1·50:1	
T. F.	...	...	...	...	...	...	1,445	905	1·60:1	508	353	1·42:1	
T. G.	...	...	...	...	...	...	900	786	1·15:1	448	322	1·39:1	
P. A.	115	181	1:1·57	1,964	2,279	1:1·16	3,473	1,076	3·22:1	772	362	2·13:1	
P. B.	58	111	1:1·91	1,628	2,146	1:1·31	3,380	1,098	3·08:1	1,175	568	2·07:1	
P. C.	210	286	1:1·36	1,870	2,415	1:1·29	3,378	1,099	3·08:1	1,475	703	2·09:1	
P. D.	133	185	1:1·39	1,866	2,524	1:1·35	3,794	1,235	3·07:1	1,692	881	1·99:1	
TOTAL ...	6,459	8,386	...	27,249	29,645	...	41,130	20,324	.	11,573	7,236	...	
Average proportion ...	...	...	1:1·29	...	...	1:1·09	...	...	2·02:1	...	...	1·6:1	
Percentage of females to total moths caught	...	...	56·5%	...	...	52·1%	...	...	33·07%	...	...	38·4%	

N.B.—The antennæ were used as the critical character for diagnosing the sex of the moths from 7th November 1912.

Appendix IV.

Statement showing distance apart of traps.

Distance between		Pj. A. and Pj. B.	... 410 yards.
Do.	do.	Pj. A. and Pj. C.	... 1,300 ,,
Do.	do.	Pj. C. and S. C.	... 600 ,,
Do.	do.	S. C. and S. B.	... 780 ,,
Do.	do.	S. B. and S. A.	... 1,020 ,,
Do.	do.	S. A. and S. D.	... 1,020 ,,
Do.	do.	S. D. and S. E.	... 640 ,,
Do.	do.	S. E. and S. F.	... 510 ,,
Do.	do.	T. A. and T. B.	... 600 ,,
Do.	do.	T. B. and T. C.	... 1,130 ,,
Do.	do.	T. C. and T. D.	... 90 ,,
Do.	do.	T. D. and T. E.	... 700 ,,
Do.	do.	T. E. and T. F.	... 1,300 ,,
Do.	do.	T. F. and T. G.	... 720 ,,
Do.	do.	T. G. and D. E.	... 750 ,,
Do.	do.	D. E. and D. B.	... 750 ,,
Do.	do.	D. B. and D. A.	... 750 ,,
Do.	do.	D. A. and D. C.	... 2,800 ,,
Do.	do.	D. C. and D. D.	... 1,500 ,,
Do.	do.	P. A. and P. D.	... 1,100 ,,
Do.	do.	P. D. and P. B.	... 1,700 ,,
Do.	do.	P. B. and P. C.	... 1,950 ,,

NOTES.

Side Lights on "Dry-Farming."—The following abstract of Bulletin No. 98 of the United States Department of Agriculture, is taken from the Bulletin of Agricultural Intelligence and Plant Diseases issued by the International Institute of Agriculture, May, 1913 :—

"In the semi-arid regions of the United States, which have been made productive by the adoption of the dry-farming system, large yields of crops are obtained with an apparently totally insufficient moisture supply in the shape of an annual rainfall of 15 inches; and the present bulletin sets forth the result of an enquiry into how far this insufficient rainfall is supplemented by an underground water-supply.

"In South Dakota the soils are derived from the underlying clays and shales, and where the latter are exposed in wells, railway cuttings, etc., they are moist almost to the point of saturation, and the moisture increases uniformly with the distance from the surface, suggesting a subterranean rather than a superficial source of supply. The whole district may be looked upon as an artesian area with a catchment area on the Eastern Slopes of the Rocky Mountains, whence the Dakota sandstone conveys the water to South Dakota, the water gradually leaking into and through the overlying clays and shales. The rate of percolation and seepage cannot be accurately stated pending systematic observation, but it has been provisionally estimated at over 12 inches per annum—sufficient to supplement the 15 inches of rainfall and produce an abundant crop.

"Another portion of the region of the Great Plains was studied in South-Western Kansas, and a detailed description of

the ground-water condition is given. The conclusion is drawn that the district is underlain by a reservoir of moisture flowing eastward, and derived both from the local rainfall and from catchment on the mountains or higher parts of the plains. The water table occasionally comes to the surface and gives rise to perennial streams and permanent ponds, but though within reach of the surface by capillary movement, it usually lies at an average depth of 30 feet, and may be considerably lowered by excessive use. A provisional estimate was made that 6 to 8 inches of water per annum would rise from the underground supply and be available for plant growth.

"It would be difficult to overestimate the importance of these results, for the areas where the subterranean movement and supply of water are indicated coincide with those where dry-farming has been most successful, and it may be inferred that there is a close connection between the two phenomena. Moreover, if this be the case, it will also explain why the system yields so far less satisfactory results when applied to other parts of the world where different geological conditions obtain."

* *
*

A PROMISING VARIETY OF SOY BEANS.—At the time when our Memoir* on the subject of Soy Beans was published we were not in a position to recommend any particular variety, but it would now appear that the Nepali variety is likely to prove a paying crop for cultivation in the Himalayas at an elevation of about four to five thousand feet.

The Nepali variety was first tested on the Kalimpong farm where it yielded at the rate of nearly 1 ton ($26\frac{1}{2}$ mds.) of seed per acre in 1911. In 1912 its yield is given by the Superintendent of the Farm, Mr. J. Wilson, as 1,170 lbs. ($14\frac{1}{4}$ mds.), and this will probably prove to be more nearly its average yield. It is a short stout upright variety with short branches close pressed

* Woodhouse, E. J., and Taylor, C. S.—The Varieties of Soy Beans found in Bengal, Bihar and Orissa and their Commercial Possibilities. Mem. Dept. of Agri. in India, Bot. Ser., V, No. 3.

to the stem, and this habit is of advantage in that it enables the crop to be weeded more efficiently and economically than in the case of the more common twining types. The variety appears to be able to grow at slightly higher elevations than the other types and is quite unsuited to cultivation in the plains of India. It should be planted as a pure and not as a mixed crop if satisfactory results are to be obtained.

As regards the value of the crop for export, it must be remembered that the value of Soy Beans for commercial purposes depends on the seeds being large and of a pale colour and possessing a low moisture and high oil content. South Russia has supplied the best beans ever put on the English market and a sample of these beans has been procured through the courtesy of Messrs. Kilburn & Co., of Calcutta. A recent comparison of the Nepali and South Russian seed shows that the Nepali variety, as grown in the Himalayas, weighs distinctly heavier than the Russian seed, but the Russian seed has a very slightly larger oil content (19°/₀ as compared with 18·5°/₀). There is not likely to be any complaint as regards excessive moisture content if the seeds are properly dried in the plains of India before despatch. The only real disadvantage possessed by the Nepali seed is its brown colour, which is likely to injure the colour of meal made from it.

A statement of the results of analysis of these two varieties and of a typical twining variety is given below :—

Variety.	South Russian.	Lal Bhetmas (type IV).	Nepali (type VI).
% Oil content ...	18·95	15·6 to 17·3	17·9 to 20·4
% Nitrogen content ...	6·09	5·6 to 6·1	6·60 to 6·88
Weight of 100 seeds ...	21·5 gr.	4·41 to 6·5	24·4 to 29·6
Colour	Pale yellow.	Brown.	Brown.

The above figures are sufficient to prove that India is capable of producing as good a quality of Soy Bean as can be produced anywhere else, but it cannot be expected that the seed will fetch its full market value unless arrangements are made for growing

and marketing large quantities of the beans in favourable localities.—(E. J. WOODHOUSE.)

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INDUSTRIAL ALCOHOL.—A great deal has been written lately in favour of the use of alcohol as a petrol substitute, the high prices recently prevailing having stimulated enquiries in this direction.

Now as the general adoption of alcohol as a fuel would clearly bring machines into direct competition with man and animals, as consumers of agricultural products from which alcohol is produced, and might raise in an acute and definite form the question of the economic value of human life, it is not a prospect to be lightly considered.

The following extract from the *Indian Trade Journal* presents one side of the question :—"In the course of a paper on "Petrol Substitutes" by Sir Boverton Redwood and Professor Vivian B. Lewes read at the Imperial Motor Transport Conference the authors remarked :—"Any petrol substitutes made from petroleum, coal, or shale were obtainable only in limited quantity, for in each case the store of raw material was in process of depletion. On the other hand, alcohol was a motor spirit which could be continuously manufactured in any required quantity, and if the Imperial Motor Transport Conference only realized this fact and used its influence in the first place to stimulate the designing of an engine and carburettor best fitted for use with this liquid, and secondly, to induce the Government to give the necessary facilities for the manufacture and use of methylated spirit for the purpose, it would have done much towards giving this country a home-produced source of power of which no foreign entanglements could rob us. By fermentation in bulk, continuous distillation, and judicious methylation all the motor spirit needed could be obtained and sold at something like 1s. a gallon, and the extended researches of the United States Government had shown that engines could be satisfactorily run on alcohol, while in spite of the calorific inferiority of alcohol practically the same power was generated as with petrol, owing to the cooler cycle, smaller quantity of air required, and greater

compression that could be used without fear of pre-ignition. Thousands of acres of land fitted for the growth of potatoes and beet were lying idle in Ireland, even in England, and when it was demonstrated to the satisfaction of the Government that the motor was ready for the new fuel the required facilities could no longer be withheld."

The fallacy of the argument can however be illustrated by an extract from a Bulletin (Farmers' Bulletin No. 429), issued by the United States Department of Agriculture, in 1911, on "Industrial Alcohol, sources and manufacture." Under the heading *Fuel* we are told.—"Little definite information is available regarding the amount of fuel necessary for the operation of a small alcohol distillery. This dearth of accurate knowledge is regrettable, for the coal bill is a prominent item in the distillery's expense account. Such data as are at hand indicate that the coal consumption—per gallon 180° alcohol produced—may vary from 11 pounds under the most favourable conditions to 38 pounds in a poorly equipped and poorly managed plant. As 11 pounds of coal as a distillery fuel yield almost 159,000 heat units and a gallon of alcohol gives about 75,000, it is apparent that the use of alcohol so produced for heating would involve a great waste and be altogether unprofitable. The coal consumption of a small distillery will be proportionally greater than that of a large one since many economies which are possible in a large plant are quite impracticable in a small one."

It would seem that as long as two heat units in coal have to be used merely to help in the concentration of one in alcohol, the use of the latter is not truly economical. It is surely better to direct attention to the economies possible in the consumption of coal, by its own resolution, by distillation, into specialized fuels, than to contemplate what might conceivably become a premature, literal taking of the bread out of the mouths of the poor in order to get over an ephemeral difficulty; a solution of which, more economical than the wholesale conversion of edible products into fuel by the methods at present available, is obviously possible.—(A. C. Dobbs.)

REVIEWS.

(a) PRACTICAL AGRICULTURAL CHEMISTRY, BY S. J. M. AULD AND D. R. EDWARDES-KER: PUBLISHED BY JOHN MURRAY. (Price 5 shillings.)

(b) A FOUNDATION COURSE IN CHEMISTRY FOR STUDENTS OF AGRICULTURE AND TECHNOLOGY, BY J. W. DODGSON AND J. A. MURRAY: PUBLISHED BY LONGMANS, GREEN & CO. (Price 3*s.* 6*d.*)

THESE two new text-books have been recently received. Considering, first, Auld and Edwardes-Ker's volume—it forms a very useful collection of experimental exercises for the student of Agricultural Chemistry, and is in fact one of the most complete works of the kind which have appeared. As the title indicates only the practical side is dealt with, theoretical matters being chiefly omitted. The illustrations are good.

Referring secondly to the little work by Messrs. Dodgson and Murray, it is difficult to mete out a like measure of praise to it. Although only a small volume, the attempt is made to cover both theoretical as also practical chemistry within its limits, with the inevitable result that neither is well done.

Speaking generally, such works as these are not very suitable for the student of the Indian Agricultural College of to-day. Whilst in Europe and America such students have, in a fairly high proportion of cases, a good knowledge of practical agriculture and gain much from a college course of science ; here, in India, the present day student is usually hopelessly ignorant of agriculture and must, if he is to become of service agriculturally, devote the major part of his time to practical agriculture. The most he can properly attempt in chemistry is a very limited course which

may enable him to understand what the science deals with, and he could not be expected to assimilate more than a small part of the matter which either of these text-books includes.—(J. W. L.).

* * *

A feature of recent numbers of the monthly *Bulletin of Agricultural Intelligence and Plant Diseases* has been the inclusion of original articles by eminent authorities on prominent agricultural questions. The June issue contains some particularly interesting articles, including two on the Swedish Crop Improvement work, by the Head of the Svalöf Institute and by Dr. Nilsson-Ehle, one of the workers, and an article on motor cultivation in Germany by Dr. Gustav Fischer, Professor of the Royal Agricultural Higher School in Berlin.

The former shew how, in spite of the apparent simplification effected by the use of the facts discovered by Mendel, the work of plant improvement is frequently complicated by the appearance of numerous cognate characters tending in similar directions, which, at the same time, open out a prospect of correspondingly close adjustment to environmental conditions.

Dr. Fischer gives an account of the development of motor ploughs in Germany, since 1910, due to the initiative of Robert Stock. The best of these ploughs appear to do thoroughly satisfactory work, but the significant statement is made that "it is usual to calculate, for interest, amortizement and repairs, 25 per cent. of the purchase price."—(A. C. D.)

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PUBLICATIONS OF PROVINCIAL AGRICULTURAL DEPARTMENTS.

The Central Provinces Agricultural and Co-operative Gazette for June maintains the interest of preceding numbers. Part I—Agriculture, contains a further instalment of Major Baldrey's lecture on Cattle of the Central Provinces; an article on the Eradication of ticks; and a note on the "Nerbudda" Reaper, an adaptation of the "Rajah" to suit local conditions, and of which the 15 machines available for sale before the last harvest were immediately disposed of.

In Part II—Co-operation, the Registrar's Notes give a vivid idea of the difficulties of instilling business principles into the working of loan societies. The issue closes with an account by the Assistant Registrar, Misbahul Osman, of Schulze-Delitzsch, one of the German pioneers of co-operation.

* * *

THE concluding number of the fourth volume of the *Poona Agricultural College Magazine* opens with an editorial "puff" of the contents which stimulates criticism.

There is an interesting note by Mr. H. M. Chibber on some Promising Leguminous Crops—a tuberous rooted climber *Pachyrhizus angulatus* and the Mozambique Bean (*Voandzeia subterranea*). Other articles of local interest include 'Notes on the Cottons of Khandesh' by K. D. Kulkarni, and 'Artificial Manures in the Karnatak' by G. L. Kottur.

An article on the Determination of Ripeness in Cane by G. R. Mahajan describes the use for this purpose of the Brix Saccharometer, which, we are told with greater precision than accuracy, "tells directly the percentage of *sucrose* in the juice,' although the author has previously quoted a typical case in which a Brix reading of 20% was given by a juice containing 2·5% of *glucose* and other impurities.

The *pundia* cane having been found to attain on the Manjri farm a maximum of 20% total solids in the juice when ripe at about 12 months from planting for gul making, the attainment of this consistency of the juice is recommended as a criterion of ripeness.

* * *

THE Bihar Department of Agriculture have issued the first number of a half-yearly *Agricultural Journal* in continuation of the Bengal *Quarterly Journal*, the last number of which issued in April, 1912. The yearly subscription is Re. 1 and the Principal of the Sabour Agricultural College is the Editor.

Judging from the present (April) number, subscribers will get good value; it contains 67 pages and 9 plates, and is well printed on good paper.

The principal articles are by officers of the College at Sabour. An account of the successful campaign against the *Agrotis ypsilon* moth, the caterpillar of which has hitherto caused extensive damage on the *tal* lands at Mokameh and elsewhere, is given by Mr. Woodhouse and Mr. Dutt; Mr. Sil writes on the improvement of *Rahar* by selection, Mr. Taylor on "Spring-wells," Mr. MacGowan on the Rajah Plough, Mr. Basu on Fungus Diseases, and Mr. Chatterji on the Chain Pump.

Of the Rajah Plough, it is stated that it works to a depth of 9 to 12 inches,—a statement that would appear to require some qualification, as the plough in question can hardly plough more than half that depth thoroughly on ordinary consolidated ground.

The comparison of the efficiency of the Chain Pump and the ordinary basket for lifting water is perhaps hardly fair to the basket, which is probably rarely used except for lifts of considerably less than the four feet at which the trials were carried out. For the very low lifts that are common in paddy cultivation, the swing basket is wonderfully effective.

The last fifteen pages are devoted to weather and crop statistics, reviews of other agricultural publications, and Departmental notes and notices.

* * *

The Madras Agricultural Calendar for 1913-14 should be a useful publication to the Madras agriculturist. It begins with information as to the various ways in which Government offers him assistance,—by loans for digging wells, buying seed, cattle, sugar-mills, etc., as well as through the Agricultural Department,—and gives a list of Bulletins and leaflets issued by the Department. Sandwiched between the pages of the Calendar proper,—which gives besides astrological information, the dates of the principal cattle fairs, etc.,—are short pithy articles on some of the chief improvements introduced by, and principles insisted on by, the Department, *e.g.* :—'The Advantages of Growing Groundnut as a Mixed Crop,' 'Cattle—the First Step in Breeding,' 'The Necessity of Improvements in Agricultural Implements,' 'The Cultivation of Cambodia Cotton,' etc. There are

also notes on Fungus diseases and insect pests, 'Birds, Friends and Foes', and on foods and manures, and the Calendar finishes with accounts of the Veterinary Department and of the Veterinary and Agricultural Colleges, and a list of Veterinary Hospitals where animals can be treated free or for a small fee.

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THE *Quarterly Journal of the Scientific Department of the Indian Tea Association* contains among other items of interest articles on the use of explosives in agriculture—with special reference to tea, and on the Soy Bean, as a green manuring crop. The Entomologist notes the occurrence of a worm belonging to the family Mermithidæ as a parasite on the tea mosquito.—(A.C.D.)

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1st FEBRUARY TO 31st JULY, 1913.

No.	Title.	Author.	Where published.
		General Agriculture.	
1	The Agricultural Journal of India, Vol. VIII, Parts II and III. Price, per part, Rs. 2. Annual subscription, Rs. 6.	Issued from the Agricultural Research Institute and College, Pusa, Bihar.	Thacker, Spink & Co., Calcutta.
2	Some Aspects of the Agricultural Development of Bihar. Bulletin No. 33 of the Agricultural Research Institute, Pusa. Price, 4 annas.	A. Howard, M.A., A.R.C.S., F.L.S., Imperial Economic Botanist, Pusa.	Government Printing, India, Calcutta.
3	Report on the Progress of Agriculture in India for 1911—12. Price, 6 annas or 7*d*.	Agricultural Adviser to the Government of India.	Ditto.
4	Indian Wheat and Grain Elevators. Price, Re. 1-4-0.	F. Noel Paton, Director-General of Commercial Intelligence, Calcutta.	Ditto.
5	Agricultural Statistics of Bengal for 1911-12. Price, Re. 1-2 or 1*s*. 9*d*.	Government of Bengal, Revenue Department.	Bengal Secretariat Book Depôt, Calcutta.
6	Annual Report of the Board of Scientific Advice for the year 1911-12. Price, Re. 1.	Issued by the Board of Scientific Advice for India.	Government Printing, India, Calcutta.
7	Annual Report of the Burirhat Agricultural Station for 1911-12. Price, 6 annas or 7*d*.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
8	Annual Report of the Rajshahi Agricultural Station for 1911-12. Price, 2 annas.	Ditto.	Ditto.
9	Annual Report of the Burdwan Farm for 1911-12. Price, 1 anna or 1*d*.	Ditto.	Ditto.
10	Annual Report of the Rangpur Farm for 1911-12. Price, 2 annas.	Ditto.	Ditto.
11	Annual Report of the Chinsura Farm for 1911-12. Price, 2 annas or 3*d*.	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
12	Annual Report of the Demonstration Farm, St. Andrew's Colonial Homes, Kalimpong, for 1911-12. Price, 3 annas or 3*d*.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
13	Annual Report of the Dacca Agricultural Station for 1911-12. Price, annas. 8 or 9*d*.	Ditto.	Ditto.
14	*Tamaker Chash* (in Bengali). Price, Re. 1-8.	Babu Jaimini Kumar Biswas, Superintendent, Rangpur Tobacco Farm.	College Press, 117-1, Bow Bazar Street, Calcutta.
15	Agricultural Journal, Vol. I, No. 1, April, 1913. Annual subscription, Re. 1 (half-yearly).	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
16	Season and Crop Report of Bihar and Orissa, 1912-13. Price, 6 annas.	Ditto.	Bihar and Orissa Government Printing Office, Patna.
17	Agricultural Statistics of Bihar and Orissa for 1911-12.	Ditto.	Govt. Press, Ranchi.
18	Report on the Atarrah Agricultural Station for the year ending 31st May, 1912. Price, 4 annas.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
19	Report of the Government Horticultural Gardens, Lucknow, for 1912-13. Price, 4 annas.	Issued by the Department of Land Records and Agriculture, United Provinces.	Ditto.
20	Report on the Government Botanical Gardens, Saharanpur, for the year ending 31st March, 1913. Price, 4 annas.	Ditto.	Ditto.
21	Report on the Agri.-Horticultural Gardens, Lahore, for 1912-13. Price, 1 anna.	Issued by the Director of Agriculture, Punjab.	Punjab Government Press, Lahore.
22	Nakhlistan, Part I (in Urdu). Price, 8 annas.	Abdul Kadar Khan	Union Steam Press, Lahore.
23	Soil: Its Treatment and Agricultural Implements (in Marathi). Price, 8 annas.	Rao Saheb G. K. Kelker, Assistant Professor of Agricultural College, Poona.	
24	Poona Furnace, Bulletin No. 48 of 1911, of the Department of Agriculture, Bombay. Price, 6 annas (in Marathi).	P. C. Patil, Divisional Inspector of Agriculture, C. D.	Government Central Press, Bombay.
25	A Note on Steam Ploughing, Bulletin No. 54 of 1912, of the Department of Agriculture, Bombay. Price, 10 annas.	A. A. Musto, P. W. D., Agricultural Engineer, Bombay.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
26	What the ryot has to say about the use of Drill for Sowing Seed. Leaflet No. 3 of 1913 (in English and Tamil).	H. C. Sampson, B.Sc., F.H.A.S., F.B.S.E., Deputy Director of Agriculture, Madras.	Government Press, Madras.
27	Training of Actual Cultivators, Maistries or Field Coolies. Leaflet No. 5 of 1913 (in English, Tamil, Telugu and Malayalam).	D. T. Chadwick, I.C.S., Director of Agriculture, Madras.	Ditto.
28	What the ryot has to say about the single Seedling planting of Paddy. Leaflet No. 6 of 1913 (in English and Tamil).	Natesa Iyer ...	Ditto.
29	The Manuring of Sugarcane at Samalkota Agricultural Station, Bulletin No. 66. Price, 9 pies.	G. R. Hilson, B.Sc., Deputy Director of Agriculture, Madras.	Ditto.
30	The Monthly Agricultural and Co-operative Gazette, February to July, 1913. Price, 2 annas per copy.	Issued by the Department of Agriculture, Central Provinces and Berar.	Desh Sevak Press, Nagpur.
31	Report on the Season and Crops of Assam for the year 1912-13. Price, 8 annas.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
32	Season and Crop Report of Burma for the year ending 30th June, 1913. Price, 8 annas or 9*d*.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
33	Annual Report of the Agricultural Stations of N.-W. F. P. for 1911-12.	Issued by the Department of Agriculture, N.-W. F. P.	Thacker, Spink & Co., Calcutta.
34	The Cultivation and Transport of Tomatoes in India. Fruit Experiment Station, Quetta, Bulletin No. 1.	A. Howard, M.A., A.R.C.S., F.L.S., and Gabrielle L. C. Howard, M.A.	Baptist Mission Press, Calcutta.
35	Some Improvements in the packing and transport of fruit in India. Fruit Experiment Station, Quetta, Bulletin No. 2.	Ditto.	Ditto.
36	The Quarterly Journal of the Madras Agricultural Students' Union. Annual subscription, Re. 1.	Madras Agricultural Students' Union.	Guardian Press, Mount Road, Madras.
37	Report on the Operations of the Department of Agriculture, Travancore, for 1911-12.	Issued by the Department of Agriculture, Travancore.	Government Press, Trivandrum.
38	Report on the working of the Gardens and Parks in Mysore during 1911-12.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.
39	Dairy Students' Union, Indian Notes.	Dairy Students' Union.	Albert Press, Quetta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—concld.		
40	Indian Tea Association Scientific Department Quarterly Journal, Part IV, 1912, and Part I, 1913.	Indian Tea Association.	Catholic Orphan Press, Calcutta.
41	The Poona Agricultural College Magazine, Vol. IV, No. 4 (Quarterly). Annual subscription, Rs. 2.	College Magazine Committee, Poona.	Arya Bhushan Press, Poona.
	Agricultural Chemistry.		
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